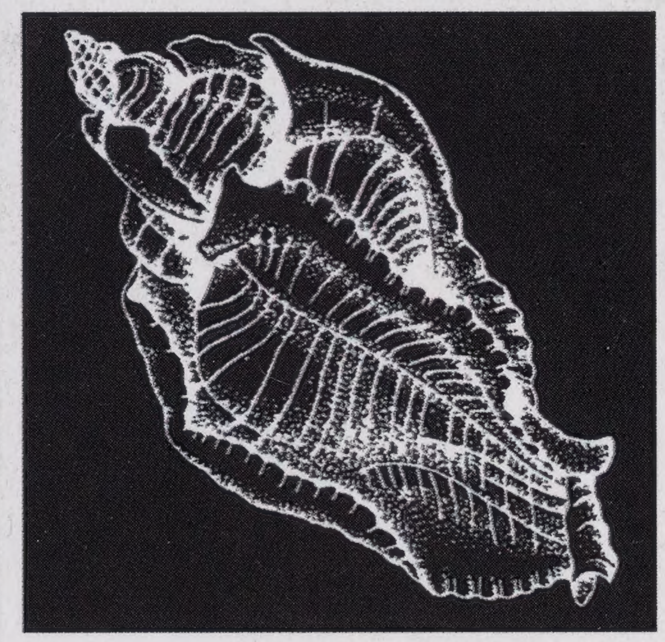


THE Festivus

Vol. 51(2) May 2019

QL
401
.F418
INVZ

A new cowrie from NW Australia

Haliotis papulata in the Indo-West Pacific

A new *Scaphella* from Yucatan, Mexico

Fossil cowries, *Amphidromus*, and more

Quarterly Publication of the San Diego Shell Club

ISSN 0738-9388

THE FESTIVUS

A publication of the San Diego Shell Club

Volume: 51 May 2019 ISSUE 2

CLUB OFFICERS

President	Lisa Dawn Lindahl
Vice-President	David P. Berschauer
Corresp. Secretary	Dave Michaelski
Treasurer	Nancy Hale
Past President	David B. Waller

COMMITTEE CHAIRPERSONS

Librarian	Dr. Paul Tuskes
Historian	Dr. Paul Tuskes
Parliamentarian	David B. Waller
Co-Editor	David P. Berschauer
Co-Editor	David B. Waller
Art Editors	Rex Stilwill & Lisa Dawn Lindahl
Publicity Chair	David P. Berschauer
Botanical Garden Rep.	Dr. Wes Farmer

MEMBERSHIP AND SUBSCRIPTION

Annual dues are payable to the San Diego Shell Club Membership: Domestic/Foreign $20 (receive e-mail copy of *The Festivus*); Domestic $35 (receive *The Festivus* by mail), Foreign/outside the continental United States $65 (receive a copy of *The Festivus* by mail). Single copies of each regular issue are $10.00 plus postage.

Address all correspondence to:
The San Diego Shell Club, Inc.
P.O. Box 230988, Encinitas, CA 92023

REGULAR CLUB MEETINGS

Club meetings are held on the third Thursday or Saturday of the month, except April, September and December, at either 7:30 p.m. in Room 104, Casa del Prado, Balboa Park, San Diego, or at 12:00 noon at other locations as noticed on the Club's website.

FACEBOOK

https://www.facebook.com/groups/620724271299410/

WEBSITE

http://www.sandiegoshellclub.com

Submit comments or suggestions regarding our website to our Webmaster Dung Vo at dungtranvo@gmail.com.

FRONT COVER:

Under water photo of a live *Marginella edwardensis* S.G. Veldsman, 2013, taken by Mike Fraser of South Africa. Photo used with permission. All rights reserved. (Cover artistic credit: Rex Stilwill).

MISSION STATEMENT

The San Diego Shell Club was founded in 1961 as a non-profit organization for educational and scientific purposes. More particularly to enjoy, study and promote the conservation of Mollusca and associated marine life through lectures, club meetings and field trips. Our membership is diverse and includes beginning collectors, scientists, divers, underwater photographers and dealers.

THE FESTIVUS is the official quarterly publication of the San Diego Shell Club, Inc. and is issued as part of membership dues in February, May, August and November. *The Festivus* publishes articles that are peer reviewed by our volunteer Scientific Peer Review Board, as well as articles of general interest to malacologists, conchologists, and shell collectors of every level. Members of the Peer Review Board are selected to review individual articles based upon their chosen field of expertise and preference. Available by request or on our website are:

- Guidelines for Authors
- Guidelines for the Description of New Taxa

Submit articles to Editor, David P. Berschauer, at shellcollection@hotmail.com

All correspondence pertaining to articles, including all submissions and artwork should be addressed to the Editorial Board.

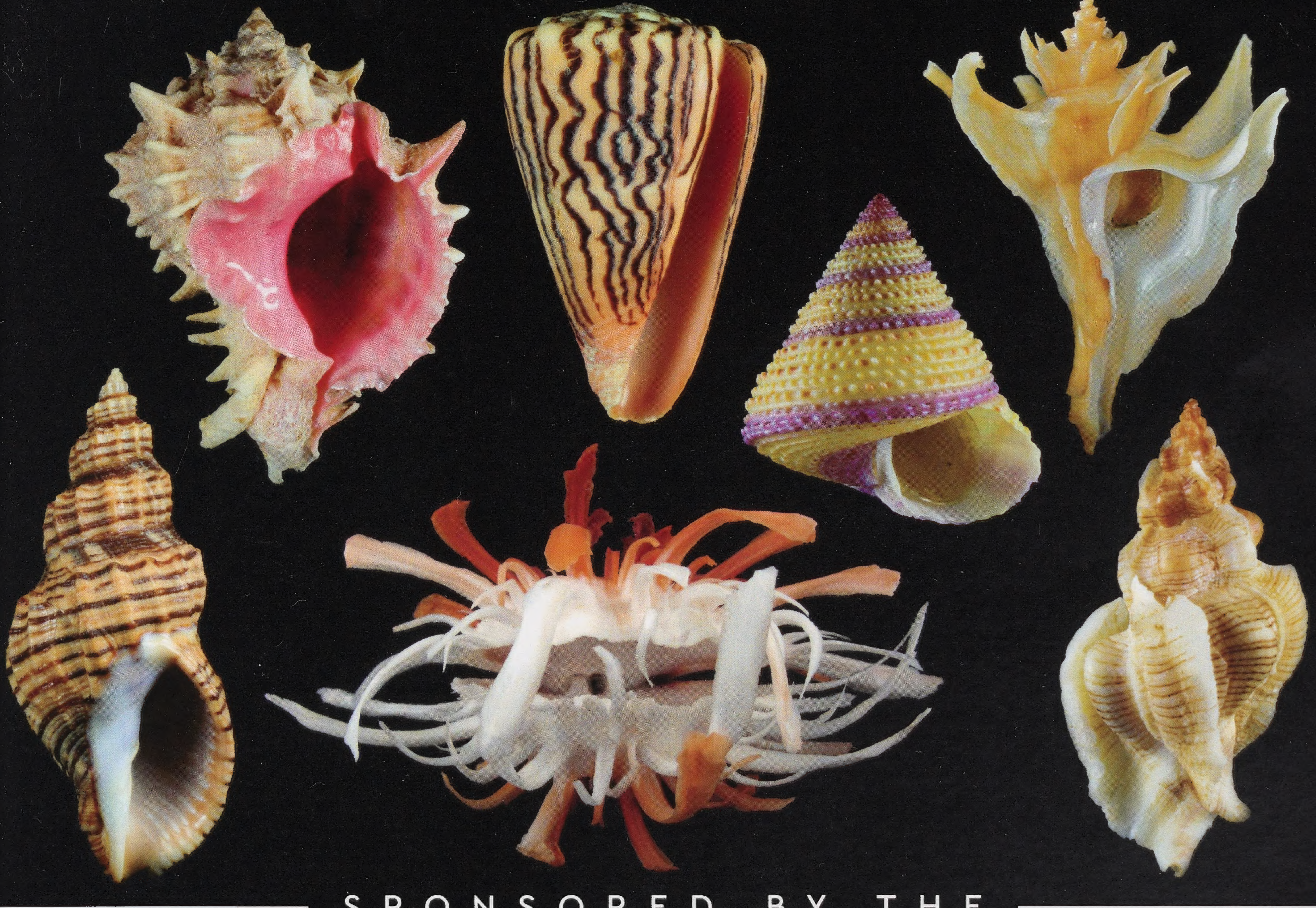
ADVERTISING in *The Festivus* is presented as a service to our membership and to supplement publication costs. Advertising does not imply endorsement by the San Diego Shell Club, Inc. or its officers. Advertising space is available at the following rates: Black and White – ½ page $300, ¼ page $150, or ⅛ page $75, Color – ½ page $500, ¼ page $250, or ⅛ page $125. Deadline for submitting advertisements is the 15th of the month prior to publication. Submit advertisements to our Advertising Director Lisa Lindahl, at: lindahldesigns@gmail.com

UPCOMING CLUB EVENTS: Mark your calendars!
San Diego County Fair - June 2019 to July 4th
June 8, 2019 - Picnic and field trip
July 29, 2019 - Shell Bazaar in San Diego
West Coast Shell Show - August 24-25, 2019

Publication date: May 1, 2019
© San Diego Shell Club, Inc.

THE FOURTH ANNUAL

WEST COAST Shell Show



SPONSORED BY THE

San Diego Shell Club

AUGUST 24-25 2019

CASA DEL PRADO

1650 EL PRADO, BALBOA PARK, SAN DIEGO, CA 92101

ROOM 101 | SATURDAY 9^{A}–7^{P} | SUNDAY 9^{A}–7^{P}

ISSN 0738-9388

TABLE OF CONTENTS

Peer Reviewed Articles

- A New Cowrie from the Estuaries of Northwestern Australia 81
  By Edward J. Petuch, David P. Berschauer, and David B. Waller
- *Haliotis papulata* Reeve 1846 (Vetigastropoda: Haliotidae), the pimpled abalone, ... 88 is the correct name for the small Indo-West Pacific abalone referred to as *Haliotis thailandis* Dekker & Patamakanthin 2001 and not as a synonym of *Haliotis varia* Linnaeus 1758
  By Buzz Owen, Aaron D. Pan, & Arjay Raffety
- A New Scaphelline Volute from the Gulf of Mexico 97
  By Edward J. Petuch and David P. Berschauer
- A new species of *Placiphorella* (Polyplacophora: Mopaliidae) from the .... 103 North American Pacific coast
  By Roger N. Clark
- Two New species of *Amphidromus* (Gastropoda: Camaenidae) from .... 108 Vietnam
  By Nguyen Ngoc Thach
- New records of nudibranchs (Gastropoda: Heterobranchia) from the coast of .... 114 Pakistan (Northern Arabian Sea)
  By Shahnawaz Gul
- The Fossil Cypraeidae of the Pinecrest Member (Unit 7), and Kissimmee River .... 125 Valley Equivalent, Tamiami Formation of Southern Florida: (Mollusca: Gastropoda: Cypraeidae)
  By John D. "Duffy" Daughenbaugh
- Taxonomic Note: *Haliotis drogini* Owen & Reitz, 2012 133

Club News 134

Articles of General Interest

- Shelling on our dream trip to Australia 136
  By Robyn Waayers
- Eighteen Months in Martinique 142
  By David Touitou
- Quick, massive (~1,000 items), manual digital photography of small (~ 1/10cm) .... 150 specimens collection by a professional digital video camera and a photo camera zoom lens
  By Cesare Brizio

SMITHSONIAN
MAY 31 2019
LIBRARIES

Volume: 51 THE FESTIVUS ISSUE 2

A New Cowrie from the Estuaries of Northwestern Australia

Edward J. Petuch [1], David P. Berschauer [2], and David B. Waller [3]
[1] Department of Geosciences, Florida Atlantic University, Boca Raton, Florida 33458
epetuch@fau.edu
[2] 25461 Barents Street, Laguna Hills, California 92653
shellcollection@hotmail.com
[3] 505 Willow Spring Drive, Encinitas, California 92024
dwaller@dbwipmg.com

ABSTRACT A new species of cowrie in the genus *Erronea (Ipserronea)* is described from the muddy coastal estuaries of King Sound, Western Australia, at the mouth of the Fitzroy River. The new cowrie, here named *Erronea (Ipserronea) garyi* n. sp., is the smallest-known member of its subgenus and inhabits oyster and *Pinna* beds on intertidal mud flats adjacent to mangrove jungles and river inlets. This new mudflat-dwelling dwarf cowrie is the fifth-known species in the subgenus *Ipserronea*.

KEY WORDS Cowrie Shells, Cypraeidae, *Erronea*, *Ipserronea*, King Sound, Western Australia

INTRODUCTION

The muddy estuarine areas of coastal northwestern Australia are still unexplored malacologically and potentially house entire new molluscan faunas that have never before been seen or described. Collecting in these areas is extremely difficult and dangerous, especially when considering the soft, flocculent mud substrate, widely-fluctuating tidal cycles, and abundant resident salt water crocodiles. Because of these impediments, few malacologists and shell collectors have ever investigated these inhospitable brackish water environments. Recently, two intrepid Western Australian collectors, Gary Smith and Allan Archer of Derby, have been exploring the King Sound region in search of new and rare species of gastropods and have made several interesting discoveries. While investigating oyster banks exposed on mud flats at low tide, they uncovered a very small and apparently new species of cowrie that lived inside the valves of dead oysters and pen shells. Upon closer examination, the new cowrie was found to represent a previously-unknown dwarf member of the subgenus *Ipserronea* of the genus *Erronea* (the *E. pyriformis* species complex; see Lorenz, 2017). The authors were made aware of this interesting new discovery by Thierry Vulliet of Arundel, Queensland, who generously sent specimens for study and who had originally received them from Josh Akerman of Broome, Western Australia. Because of the exhaustive field work of Smith and Archer and the generosity of Vulliet, we are here able to describe this new *Ipserronea* species and a new addition to the Australian cowrie fauna.

The holotype of the new cowrie is deposited in the Western Australian Museum in Perth, Western Australia and bears a WAM catalog number. Paratypes of the new species are deposited in the collections of the Department of Malacology, Los Angeles County Museum of Natural History, Los Angeles, California and bear LACM catalog numbers.

SYSTEMATICS

Class Gastropoda
Subclass Sorbeoconcha
Order Prosobranchia
Infraorder Mesogastropoda
Superfamily Cypraeoidea
Family Cypraeidae
Subfamily Erroniinae
Genus *Erronea* Troschel, 1863
Subgenus *Ipserronea* Iredale, 1935

Erronea (Ipserronea) garyi
Petuch, Berschauer, and Waller, new species
(Figure 1 A-L)

Description. Shell small for genus and subgenus, averaging around 20 mm in length, ovately pyriform, greatly inflated, with high humped dorsum; extremities pronounced and well-developed; anterior extremities narrow and pointed, with distinct constriction at juncture with body whorl; posterior extremities asymmetrical, with labial extremity being better-developed and extending farther from body whorl; margins heavily callused and thickened; base rounded, heavily callused, extending well beyond marginal line, giving shell globular appearance; dorsum pale tan or whitish-tan, with an extremely light wide band of flammules slightly darker than the dorsum, overlaid with numerous very small flecks of darker tan-brown; margins white, marked with 8-10 proportionally-large elongated brown spots; base and extremities pure white; apical pit on posterior end marked with large dark brown spot; single pale brown spot present along base of labial anterior extremity; columella with 17-20 small, thin teeth which are confined to apertural area and do not extend onto shell base; columellar teeth pale reddish-tan within aperture, becoming white along edge of base; labium with 16-18 large pointed teeth, pure white in color; interior of aperture white or pale whitish-tan, with large pale reddish-brown patch at anterior end.

Type Material. HOLOTYPE - Length 23.2 mm, width 14.7 mm, from mud flats at the mouth of the Fitzroy River, King Sound, Western Australia, WAMS 72490 (Figure 1 A-C); **OTHER MATERIAL EXAMINED** - length 21.5 mm, from the same locality as the holotype, in the Berschauer Collection (Figure 1 D-F); length 21.4 mm, from the same locality as the holotype, in the Waller Collection (Figure 1 G-I); length 18.2 mm, from the same locality as the holotype, in the Petuch Collection (Figure J-L); 2 subadult specimens, from the same locality as the holotype, in the Berschauer Collection.

Type Locality. The type lot was collected inside dead oyster shells on an exposed oyster bank, on the mud flats off Marv Island, King Sound, Western Australia.

Distribution. At present, known only from the King Sound area of Western Australia, but may be present in most of the muddy estuaries along extreme northern Western Australia and also Northern Territory.

Ecology. *Erronea (Ipserronea) garyi* prefers intertidal estuarine environments at the mouths of rivers, where it occurs on isolated oyster beds growing in extensive flocculent mud flats and muddy clay banks. Here, it occurs along with the delicate winged muricid *Timbellus bednalli*. These estuarine areas also house populations of the large Saltwater Crocodile, *Crocodylus porosus*.

Etymology. Named for Gary Smith of Derby, Western Australia, who discovered the new cowrie while exploring the muddy estuaries of the King Sound area.

Discussion. The subgenus *Ipserronea* Iredale, 1935, differs from the other subgenera and species groups within *Erronea* by having distinctly pyriform shell shapes, narrow apertures, and pronounced columellar teeth which often extend onto the shell base. Ranging from southern India eastward to Queensland, Australia and the Coral Sea, *Ipserronea* is now known to contain five species. We recognize the following taxa (whose biogeographic ranges were taken from Lorenz, 2017: 551):

1. *Erronea (Ipserronea) pyriformis* (Gray, 1824) (Taiwan south to the Philippines, New Guinea, Indonesia, and the Andaman Sea and Bay of Bengal) (Figure 2 C, D);

2. *Erronea (Ipserronea) carnicolor* (Preston, 1909) (eastern Australia, from the Torres Strait, the entire Queensland coast and Great Barrier Reef, to northern New South Wales, and the Coral Sea) (Figure 2 E, F);

3. *Erronea (Ipserronea) smithi* (Sowerby III, 1881) (Western Australia and Northern Territory, Australia, from Shark Bay to Arnhem Land) (Figure 2 A, B);

4. *Erronea (Ipserronea) angioyorum* (Biraghi, 1978) (southwestern India) (Figure 2 G, H);

5. *Erronea (Ipserronea) garyi* new species (northern Western Australia) (Figure 1 A-L).

The type species of Iredale's subgenus *Ipserronea* is *I. problematica*, which is now known to be a synonym of the eastern Australian *I. carnicolor* (see Iredale, 1935; Lorenz, 2017). As the type of the subgenus, *E. carnicolor* encompasses the main shell characters that set this species group aside from the other known subgenera of *Erronea*, such as *Adusta* (*E. adusta* group), *Solvadusta* (*E. subviridis* group), and *Palangerosa* (*E. cylindrica* group). All five species exhibit a definite pyriform shape and inflated shell body and resemble the cypraeid genus *Ficadusta*.

Of the five known species of *Ipserronea*, *E. garyi* is morphologically closest to *E. smithi* (Sowerby III, 1881) from northwestern and northern Australia. Lorenz (2017: 552) considered *E. smithi* to be a subspecies of *E. pyriformis* but, because of very different shell characters and the different biogeographical ranges, we here consider *E. smithi* to be a full species, distinct from the widespread *E. pyriformis*. Although occurring in the same general region of Australia, *E. smithi* and *E. garyi* have completely different ecological preferences, with *E. smithi* preferring deeper offshore areas, most often in association with beds of *Pinctada* pearl oysters in 15-25 m depths, with open-oceanic water conditions (Lorenz, 2017: 552). Some specimens of *E. smithi* have been taken in depths as great as 120 m, where they were collected from fish traps. *Erronea garyi*, on the other hand, prefers muddy intertidal estuarine areas near the mouths of rivers, where it lives in association with *Ostrea* and *Saccostrea* oyster banks and is often exposed at low tide. To avoid the extreme summer heat and fluctuating salinities during exposure at low tide, the new species finds refuge within the valves of dead oysters (Gary Smith, personal communication) and all of the specimens in the type lot were collected in this kind of habitat.

The shell morphology of the estuarine *Erronea garyi* also differs from that of the deeper water *E. smithi*, with the new species being a much smaller shell, averaging only 19-20 mm, while its offshore congener is generally a larger shell, averaging 29-30 mm. The new species is also a much more inflated and globose shell, with a higher, more domed dorsum and a noticeably more rounded base than those seen on the more flattened, dorsally-compressed *E. smithi*. The shell color of *E. smithi* is consistently a pale blue or greenish-blue, overlaid with two wide bands of large brown or purplish-brown rectangular flammules, while the color of *E. garyi* is a pale tan or whitish-tan with an extremely light wide band of flammules that is slightly darker tan than the dorsum. The flattened base of *E. smithi* has a characteristic bright yellow color that becomes darker on the anterior and posterior extremities, while the rounded base of *E. garyi* is simply pure white. The colors of the interiors of the apertures also differs greatly between the two Western Australian species, with the interior of *E. smithi* being a dark brown or deep purplish-brown while the interior of *E. garyi* is white or pale whitish-tan. For comparative photographic views of both species see Figure 3.

The general shell shapes also differ greatly between the two western Australian species, with *E. smithi* having a wider shell with broader and more flattened extremities, while *E. garyi* has narrower and more pointed extremities with a greater constriction at the body whorl juncture. The greatest difference between the two congeners is seen in the shape and form of the columellar teeth; in *E. smithi* the teeth at the posterior end of the columella are proportionally large, extend onto the shell base, and are colored a dark reddish-brown (Figure 2 B), while the posterior columellar teeth of *E. garyi* are proportionally very small, do not extend onto the base of the shell, and are colored a faint reddish-tan only deep within the aperture (Figure 1 B). In regards to this last shell character, the new species somewhat resembles the southern Indian *E. angioyorum* (Figure 2 H).

ACKNOWLEDGMENTS

We thank the following for their generous contributions of study specimens: Gary Smith, Derby, Western Australia, for the donation of the holotype specimen and type lot; Thierry Vulliet, Arundel, Queensland, Australia, for a specimen of the new species (shown here on Figure 1 J-L) and for the specimen of *Erronea smithi* shown on Figure 2 A, B); Josh Akerman, Broome Western Australia and Thierry Vulliet, Queensland, Australia for bringing the new species to our attention; Dr. Felix Lorenz for preliminary consultation; and Corey Whisson of the Western Australian Museum for his assistance in obtaining the type number.

REFERENCES

Iredale, T. 1935. Australian Cowries. The Australian Zoologist 8(2):96-135, plates 8, 9.

Lorenz, F. 2017. Cowries: A Guide to the Gastropod Family Cypraeidae. Volume 1. Biology and Systematics. ConchBooks, Harxheim, Germany. 644 pp.

Editor's Note: *The Festivus* is accepting articles for future issues. Articles of a scientific nature may be submitted for the peer reviewed portion of our journal. Please refer to our Guidelines for Authors, and/or Guidelines for the Description of New Taxa in *The Festivus*, both available on our website: http://www.sandiegoshellclub.com/festivus/.

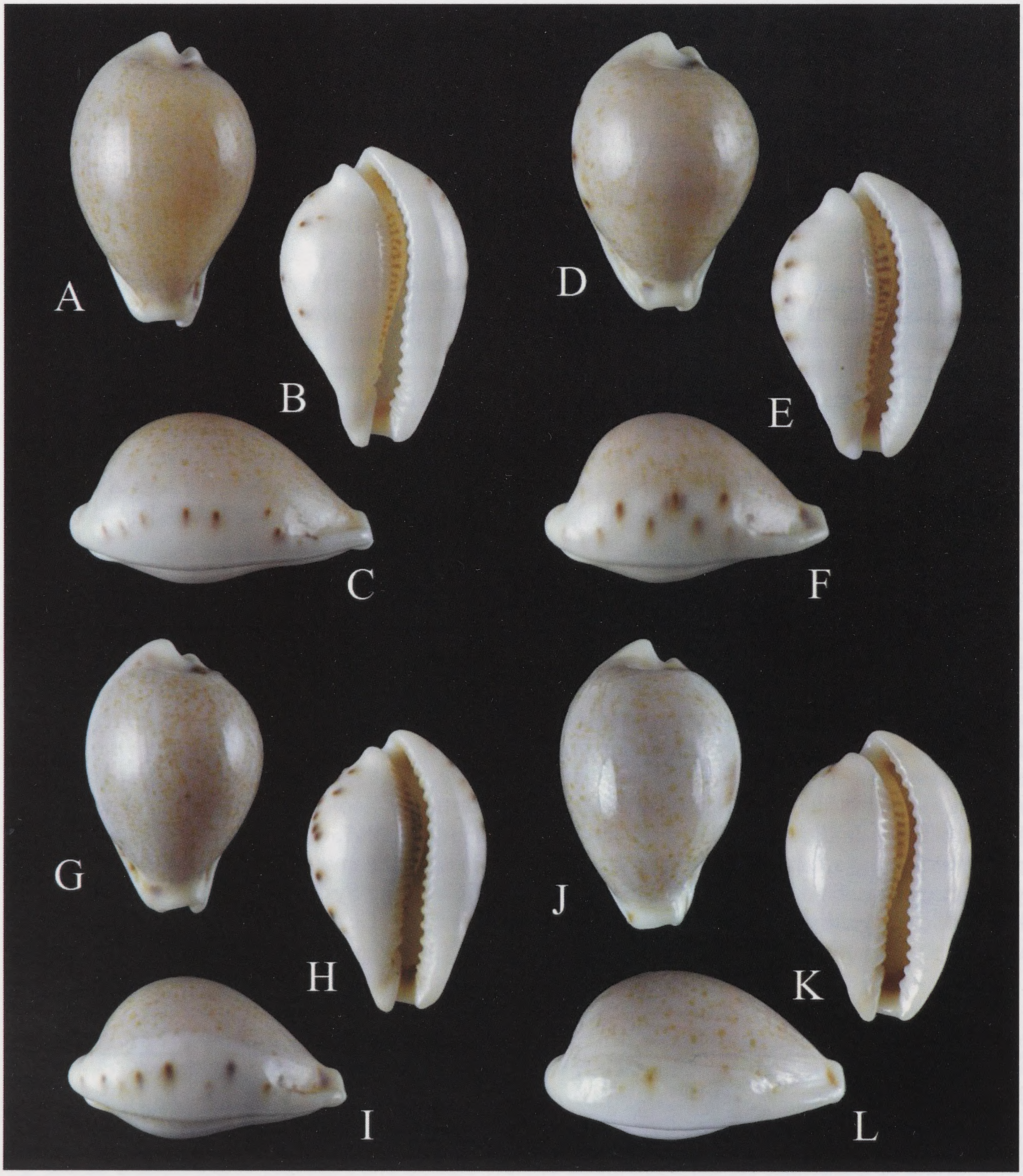


Figure 1. ***Erronea (Ipserronea) garyi*** **Petuch, Berschauer, and Waller, new species from the Estuaries of Western Australia.** **A, B, C=** Holotype, length 23.2 mm, King Sound, Western Australia, WAMS 72490; **D, E, F=** 21.5 mm specimen, King Sound, Western Australia, Berschauer Collection; **G, H, I=** 21.4 mm specimen, King Sound, Western Australia, Waller Collection; **J, K, L=** 18.2 mm specimen, King Sound, Western Australia, Petuch Collection.

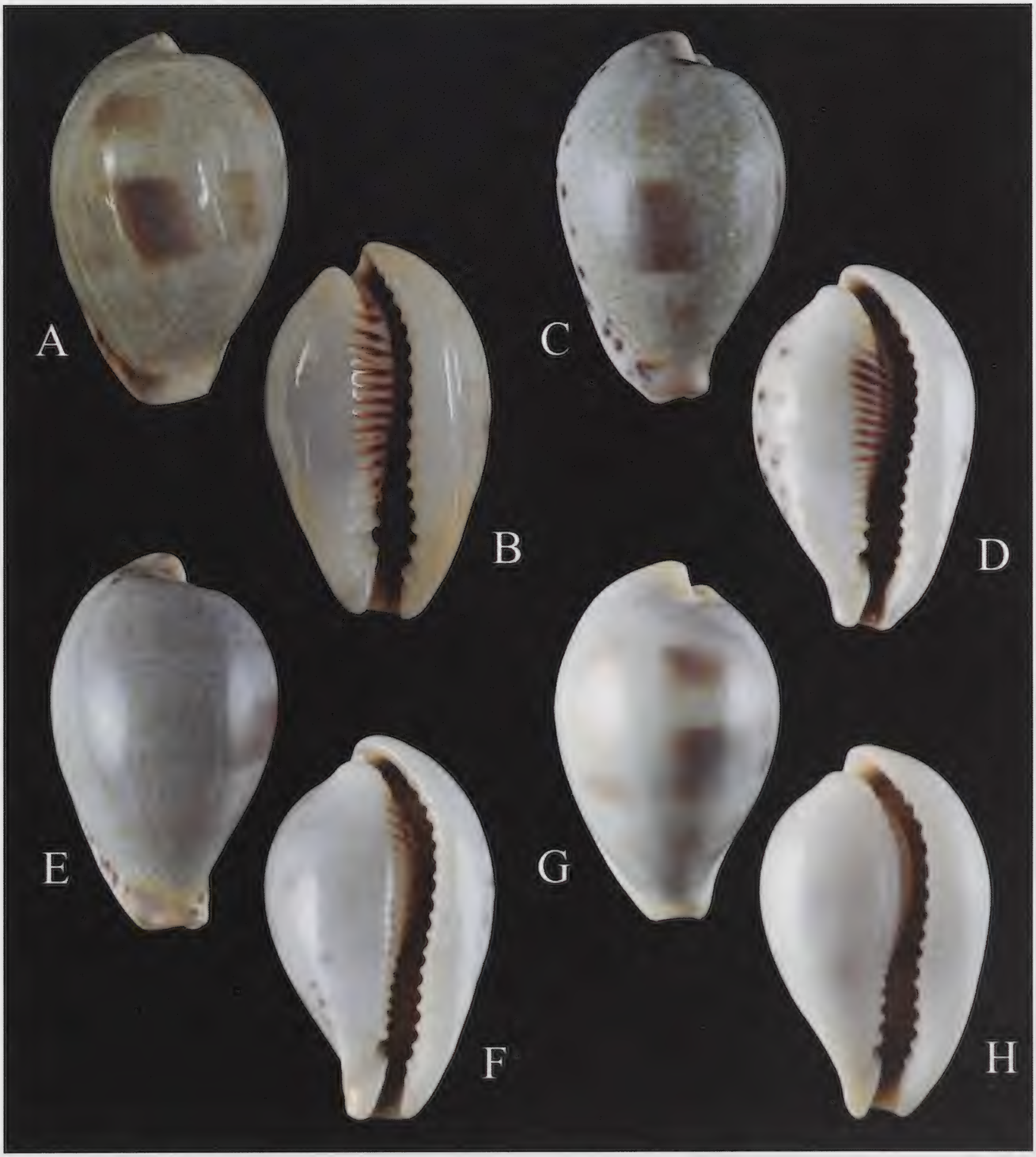


Figure 2. Species of *Erronea (Ipserronea)* from the western Pacific and eastern Indian Oceans. **A, B=** *Erronea (Ipserronea) smithi* (Sowerby, 1881), length 26.3 mm, trawled from 50 m depth off Cape Leveque, Dampier Peninsula, Western Australia; **C, D=** *Erronea (Ipserronea) pyriformis* (Gray, 1824), length 31 mm, trawled from 30 m depth off Panglao, Bohol Island, Philippines; **E, F=** *Erronea (Ipserronea) carnicolor* (Preston, 1909), length 36 mm, trawled from 40 m depth off Tanum Sands, Queensland, Australia; **G, H=** *Erronea (Ipserronea) angioyorum* (Biraghi, 1978), length 27.6 mm, trawled by shrimpers from 80 m depth off Kerala, India.

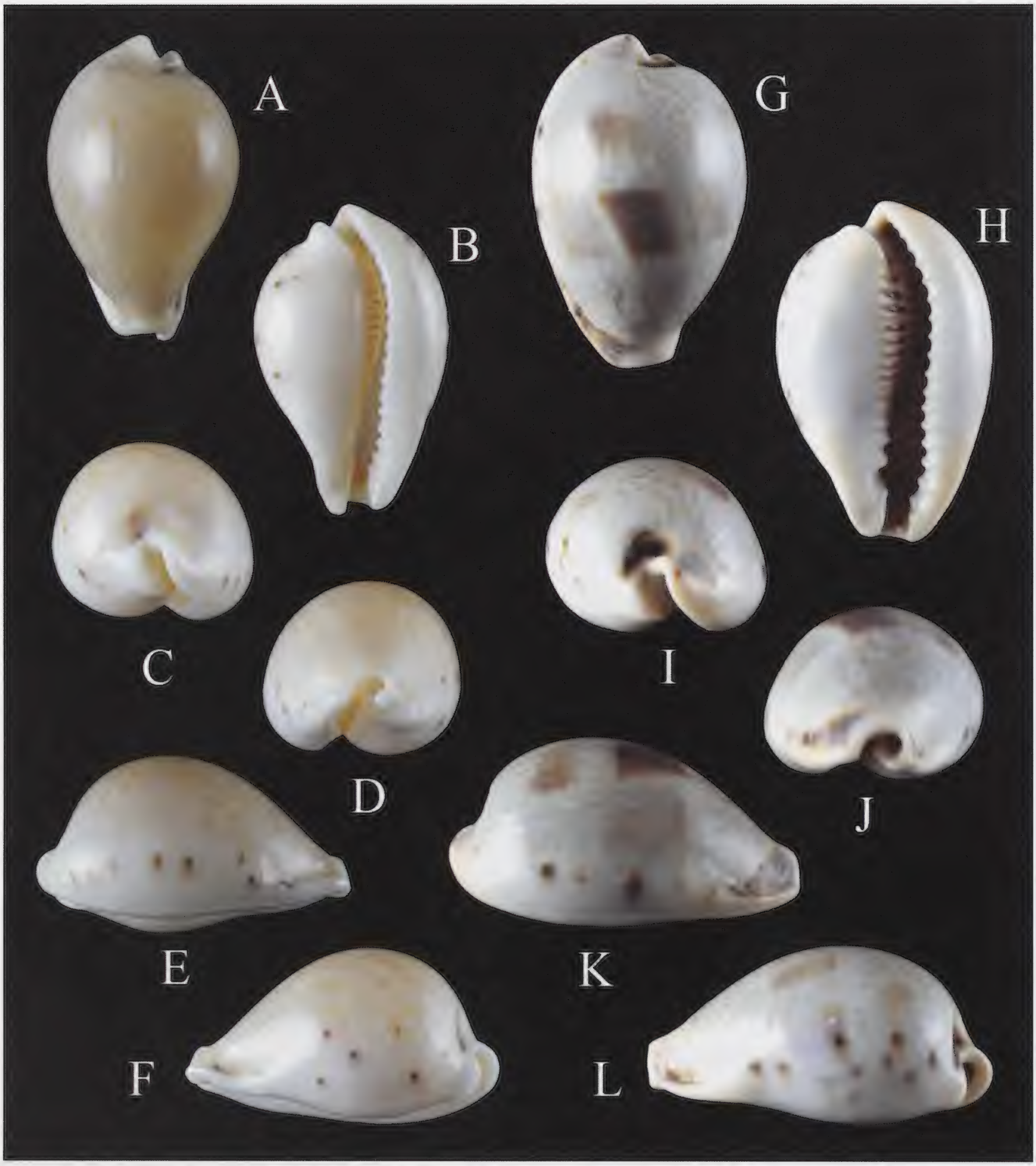


Figure 3. Comparison between *Erronea (Ipserronea) garyi* and *Erronea (Ipserronea) smithi*. **A-F** = six views of the holotype of *Erronea (Ipserronea) garyi* Petuch, Berschauer, and Waller, new species, length 23.2 mm. **G-L** = six views of *Erronea (Ipserronea) smithi* (Sowerby, 1881), length 26.3 mm.

ISSN 0738-9388

Haliotis papulata Reeve 1846 (Vetigastropoda: Haliotidae), the pimpled abalone, is the correct name for the small Indo-West Pacific abalone referred to as *Haliotis thailandis* Dekker & Patamakanthin 2001 and not as a synonym of *Haliotis varia* Linnaeus 1758

Buzz Owen[1], Aaron D. Pan[2, 3], & Arjay Raffety[4]
[1] P.O. Box 601, Gualala, CA 95445, buzabman@mcn.org
[2] Don Harrington Discovery Center, 1200 Streit Drive, Amarillo, TX 79106, apan@dhdc.org
[3] Botanical Research Institute of Texas, 1700 University Drive, Fort Worth, TX 76107
[4] P.O. Box 338, Elk, CA 95432-0338, JArjayR@aol.com

ABSTRACT The syntypes of *Haliotis papulata* Reeve 1846 have been re-examined and are found to not represent specimens of *H. varia* Linnaeus 1758. *Haliotis papulata* appears to be the correct name for specimens that are currently considered *H. thailandis* Dekker & Patamakanthin 2001. The synonymy of *Haliotis thailandis* within *H. papulata* provides a more detailed understanding of the distribution of the species and its probable close phylogenetic relationships with the Indo-Pacific abalone species, *Haliotis unilateralis* Lamarck 1822 and *H. clathrata* Reeve 1846.

KEY WORDS Haliotidae, *Haliotis papulata*, *Haliotis thailandis*, *Haliotis varia*

INTRODUCTION

Haliotis papulata Reeve 1846, the pimpled abalone, was originally described by Reeve (1846). However, since its original description a number of authors have considered the species a synonym of *Haliotis varia* Linnaeus 1758, including Talmadge (1962), Geiger (1998), and Geiger & Owen (2012). Recently, one of the authors (B. Owen) photographed Haliotidae specimens from the Hugh Cuming collection at the Natural History Museum, United Kingdom in London which includes Reeve's *Haliotis* type material (Reeve 1846; Dance 1980). Amongst the collection are three shells belonging to *Haliotis papulata* Reeve 1846, from the 'north coast of Australia', representing the syntypes of the species. (Figure 1: images 1-4). These specimens do not match the characteristics of *Haliotis varia*; especially specimens from northern Australia or the West Pacific, even when taking morphological variability of *H. varia* shells into account (Figure 3: images 1-4).

Here we provide evidence that *Haliotis papulata* does not represent *Haliotis varia* and that the recently described species, *Haliotis thailandis* Dekker & Patamakanthin 2001, actually represents *H. papulata* and thus, should be considered a junior synonym of the latter.

MATERIAL

Abbreviations of Collections.
ARC: Arjay Raffety Collection;
BOC: Buzz Owen Collection;
MHNG: Muséum d'Histoire Naturelle, Geneva, Switzerland;
NMHUK: Natural History Museum, London, United Kingdom;
RKC: Robert Kershaw Collection;
FFC: Franck Frydman Collection;
CIE: Conchology Incorporated Encyclopedia;
KSC: Katherine Stewart Collection.

Note: All specimens in figures in BOC unless otherwise indicated.

Shells Examined. *Haliotis papulata* – 3 (syntypes); *Haliotis thailandis* – >90; *Haliotis unilateralis* – >100; *Haliotis varia* (Northern Territory, Australia) – >75; *Haliotis varia* (other localities) – >1,000.

RESULTS

Haliotis papulata Reeve 1846

Synonyms: *Haliotis thailandis* Dekker & Patamakanthin 2001

Type material. Syntypes: NHMUK 1950.3.16.9 – 11 (Figure 1: images 1-4)

Type Locality. 'North coast of Australia' (Reeve 1846)

Original Diagnosis. 'Hal. testá suborbiculari-ovatá, spiraliter obtuso-liratá, liris subdistantibus, conspicuè tuberculatis; foraminibus subtubiferis, quaternis perviis; corallo-rubidá, flavescente variá (Reeve 1846)'.

Original Translation. 'Shell somewhat orbicularly ovate, spirally obtusely ridged, ridges rather distant, conspicuously tuberculate; perforations sub-tubiform, four open; dark coral-red, variegated here and there with patches of yellow (Reeve 1846b).'

Description. Shell small (to 30 mm) lightweight, oval, flat, little arched. Spire little elevated, visible in ventral view, located approximately 35-40% towards posterior margin of shell. Columella of moderate width. Holes large, usually 3-5 open, somewhat raised. Dorsal surface with rows of relatively large nodules to small pustules in spiral orientation, fine growth lines. Coloration usually overall reddish; apex often pink, dorsal surface bright red to dark orange or purple, somewhat mottled with spots in other shades of red, green, or white, often with blotches in proximity to row of holes. Nacre bright, often with a pink sheen. No muscle scar is present.

Distribution and habitat. The Indo-West Pacific extending from the Laccadive Sea in the northwest to the northern coast of Australia and New Guinea in the southeast. The species is particularly notable in the coastal waters near Phuket Province in southern Thailand and the Camotes Sea region of the Philippines archipelago. Specific localities include: Arippu (Aripo), Sri Lanka; Olango Island, Philippines; Ko(h) Racha Yai Island (also known as Racha Island), Mai Thon Island, and Phuket Island, Thailand; southeast of Nuakata Island, Milne Bay, Milne Bay Province, Papua New Guinea (Dekker & Patamakanthin 2001; Geiger & Owen 2012; personal observation).

This species occurs in sublittoral environments, typically found between 10-25 meters in depth (Dekker & Patamakanthin 2001; Geiger & Owen 2012). Dekker & Patamakanthin (2001) record that in southern Thailand, this species occurs on bivalves that are cemented to the sea floor and appears to feed on the encrusting or epizoan flora and/or fauna located on them and on the associated hard benthic substrates.

DISCUSSION / REMARKS

Resurrection of *Haliotis papulata* as a valid species

Talmadge (1962) synonymized several species described by Reeve (1846), including *Haliotis papulata*, into *Haliotis varia* based on the observations by S.P. Dance of the Hugh Cuming malacological collection at the British Museum of Natural History (now the Natural History Museum, London, United Kingdom; Dance 1980). Talmadge (1962), however, did not directly observe these type specimens. Reeve (1846) used these 3 specimens from this collection as his syntypes of *Haliotis papulata* and these differ greatly from *Haliotis varia* in a number of characteristics. The *Haliotis papulata* syntypes range in size from 23.7-30 mm in length while *H. varia* can reach up to sizes of 86 mm, and are typically larger than 40 mm in length (Figure 3: images 1-2; Geiger & Owen 2012). The *Haliotis papulata* shells are slightly arched, forming a relatively flattened convex profile, while *H. varia* shells are arched, forming convex to highly convex shells (Geiger & Owen 2012). The shell spire position of *Haliotis papulata* is located more medially in contrast to *H. varia*, with the spire located more distally towards the posterior portion of the shell (Figure 1: images 1-4 & 18-20; Figure 2: images 1-20). In addition, discrete spirally-arranged rows of nodules are not formed in *Haliotis varia*, although some thickened ridges can form areas with swellings that look somewhat reminiscent of nodules (Figure 3: images 3-4).

Synonymy of *Haliotis thailandis*

Haliotis thailandis was originally described based on shells collected from the Andaman Sea, specifically coastal and insular waters around Phuket and Krabi Provinces, Thailand (Dekker & Patamakanthin 2001). Dekker & Patamakanthin (2001) defined the species based on the small size of the shells, generally 3-4 prominent spirally oriented rows of nodules, weak growth lines, 3-5 opened tremata, and shell coloration. Although four animals were available for study and imaged, Dekker & Patamakanthin (2001), did not describe them in detail or make one of these specimens with a preserved animal as the holotype, or include them among the paratypes.

The *Haliotis papulata* syntype specimens are small in size (23.7-30 mm), oval in shape, have low apices, possess 3-4 rows/spirals of nodules, and have 4-5 open tremata (Figure 1: images 1-4). These shell characteristics align well with *Haliotis thailandis* described by Dekker & Patamakanthin (2001). Although *Haliotis thailandis* was originally described based on material only known from the Andaman Sea around southern coastal Thailand (considered endemic to that area at the time of the study), additional specimens sharing morphological characteristics with the species and attributed to it have been recovered from other areas of the Indo-West Pacific since 2001 including the Laccadive Sea and Bay of Bengal around coastal Sri Lanka, the Camotes Sea (Olango Island, Visayas, Philippines) and New Guinea in the West Pacific (Figure 2: images 16-20; Dekker & Patamakanthin 2001; Geiger & Owen 2012; personal observations). Based on the examination of Reeve's material and the more widespread Indo-West Pacific distribution of the taxon Dekker & Patamakanthin (2001) described, *Haliotis papulata* appears to be the correct name for this taxon due to the much earlier date of publication. *Haliotis thailandis* is designated here as a junior synonym based on the rules of International Commission on Zoological Nomenclature.

In addition, with the synonymy of *Haliotis thailandis* within *H. papulata*, the images of the live animals in Dekker & Patamakanthin (2001) and habitat provide further evidence that *H. papulata* does not represent *H. varia*. The live animals of *Haliotis papulata* possess elongate filamentous epipodial tentacles with alternate light-dark band coloration, a characteristic also found in *H. clathrata* Reeve 1846 and *H. unilateralis* Lamarck 1822 (Figure 1: images 16-17; Stewart & Geiger 1999; Dekker & Patamakanthin 2001; Geiger & Owen 2012). The epipodial tentacles of *Haliotis varia* do not possess alternate light-dark color banding on the epipodial tentacles and the tentacles are not filamentous (Geiger 1999; Dekker &

Patamakanthin 2001; Geiger & Owen 2012). Moreover, *Haliotis varia* usually occurs in shallower environments than *H. papulata*, typically found in the intertidal zone and shallower portions of the subtidal zone (Geiger & Owen 2012).

Possible Evolutionary Relationships and Biogeography

Although molecular phylogenetic studies have sampled and analyzed a number of species of abalone, *Haliotis papulata* (syn. *H. thailandis*) has not been part of such studies (Lee & Vacquier 1995; An *et al.* 2005; Degnan *et al.* 2006; Streit *et al.* 2006; Bester-van der Merwe *et al.* 2012). The small size, flattened to slightly convex shape of the shell, prominent spirally oriented rows of nodules, spire orientation, shell coloration, and filamentous epipodial tentacles with light-dark band coloration provides evidence of a probable close relationship with *Haliotis unilateralis* (which has also not been sampled in any molecular phylogenetic analyses; Figure 1: images 16–17; Geiger & Owen 2012; Owen & Pan 2016).

Haliotis unilateralis is endemic to the Western Indian Ocean (WIO), including the Red Sea, and allopatric divergence between *Haliotis papulata* and *Haliotis unilateralis* across the Indian Ocean basin is possible (Geiger & Owen 2012; Owen & Pan 2016). While the resemblance of the shell morphology and epipodial characteristics of *Haliotis papulata* and *Haliotis unilateralis* specimens from the Western Indian Ocean, particularly coastal portions of Mozambique, are very similar and likely indicate a close relationship, we currently do not consider them to represent the same species due to the significant spatial distance between populations of these two taxa and the likely absence of gene flow between them (Geiger & Owen 2012; Owen & Pan 2016). The easternmost population of *Haliotis unilateralis* is located at the northern end of the Gulf of Oman, while the westernmost population of *Haliotis papulata* appears to be located in the northeastern portion of the Laccadive Sea near Arippu, Sri Lanka (Geiger & Owen 2012; Owen & Pan 2016). In addition, populations of abalone with shell morphological features similar to either of these two taxa have not been recovered from coastal or island areas along the Arabian Sea coastlines of India, Pakistan, Iran, or the Maldives. It is interesting to note that a number of other marine organisms show similar distributions and possible allopatric speciation between closely related taxa that occur either in the Western Indian Ocean or the Eastern Indian Ocean (EIO) and/or Western Pacific Ocean. One example is within the genus *Callistocypraea* (Cypraeidae), with two sister species *Callistocypraea broderipii* and *C. nivosa* (Meyer 2004; Lorenz 2017). *Callistocypraea broderipii* is endemic to the Western Indian Ocean, occurring along the African coast from KwaZulu-Natal northward to the Horn of Africa and extending across to the Mascarenes (Meyer 2004; Lorenz 2017). *Callistocypraea nivosa* is found in the Andaman Sea and the Bay of Bengal in the EIO (Meyer 2004; Lorenz 2017). Evidence can also be found within marine mammals. A recent study by Chanfana (2018) indicates that closely-related humpback dolphin species, *Sousa plumbea* and *S. chinensis*, show no evidence of gene flow, with *Sousa plumbea* occurring in the WIO and the Arabian Sea and *S. chinensis* distributed in the Bay of Bengal, Laccadive Sea, and EIO (Chanfana 2018). Other examples can be found in the Strombidae, Mullidae, and scarine labrids (Uiblein 2011; Choat *et al.* 2012; Wilson 2013).

The light-dark band colored, elongate epipodial tentacles also suggest a close relationship with *Haliotis clathrata*, although shell characteristics differ between the two taxa (Dekker &

Patamakanthin 2001; Geiger & Owen 2012). Future molecular phylogenetic studies of the abalones need to include comprehensive sampling of *Haliotis clathrata*, *H. papulata*, and *H. unilateralis* (including individuals from the Arabian Peninsula, the Mascarenes, Mozambique, and the Red Sea population that displays a distinctive rut between the row of tremata and the columella on the dorsal side of the shell) and determine if the hypothesis that these taxa are closely related and possibly form a species complex is confirmed. In addition, it is likely that with more molecular phylogenetic studies, it will be possible to determine if some of the Indo-Pacific species turn out to either be paraphyletic or represent complexes with numerous cryptic and/or ecological species, particularly with the amount of Neogene tectonism, sea level changes, and evolutionary divergence that has occurred within numerous other marine organisms in the Indo-West Pacific (Meyer 2004; Renema *et al.* 2008; Williams & Duda 2008; Bromfield & Pandolfi 2011; Bowen *et al.* 2013; Briggs & Bowen 2013; Gaither & Rocha 2013; Lorenz 2017).

ACKNOWLEDGEMENTS

We would like to thank John Ablett from the Natural History Museum in London for collection information. We would also like to thank Franck Frydman, Philippe Poppe, and Tom Rice for kindly providing permission and allowing us to use their specimens for examination and/or images in this work. We would also like to thank our reviewers who greatly improved this paper.

LITERATURE CITED

An, H-S., Y-J. Jee, K-S. Min, B-L. Kim, S-J Han. 2005. Phylogenetic analysis of six species of Pacific abalone (Haliotidae) based on DNA sequences of 16s rRNA and cytochrome *c* oxidase subunit I mitochondrial genes. Marine Biotechnology 7:373-380.

Bester-van der Merwe, A.E., M.E. D'Amato, B.L. Swart, R. Roodt-Wilding. 2012. Molecular phylogeny of South African abalone, its origin and evolution as revealed by two genes. Marine Biology Research 8:727-736.

Bowen, B.W., L.A. Rocha, R.J. Toonen, S.A. Karl, ToBo Laboratory. 2013. The origins of tropical marine biodiversity. Trends in Ecology & Evolution 28:35 -366.

Briggs, J.C., B.W. Bowen. 2013. Marine shelf habitat: biogeography and evolution. Journal of Biogeography 40:102 -1035.

Bromfield, K., J.M. Pandolfi. 2011. Regional patterns of evolutionary turnover in Neogene coral reefs from the central Indo-West Pacific Ocean. Evolutionary Ecology 26:375-391.

Chanfana, C.S.J. 2018. Genomics of speciation in humpback dolphins. University of Lisbon, MSc Thesis, 1-38.

Choat, J.H., O.S. Klanten, L. van Herwerden, D.R. Robertson, K.D. Clements. 2012. Patterns and processes in the evolutionary history of parrotfishes (family Labridae). Biological Journal of the Linnean Society 107: 529-557.

Dance, P. 1980. Hugh Cuming (1791-1865) Prince of collectors. Journal of the Society for the Bibliography of Natural History 9:477-501.

Degnan, S.M., M.A. Imron, D.L. Geiger, B.M. Degnan. 2006. Evolution in temperate and tropical seas: disparate patterns in southern hemisphere abalone (Mollusca: Vetigastropoda: Haliotidae). Molecular Phylogenetics and Evolution 41:249-256.

Dekker, H., S. Patamakanthin. 2001. Description of a small new *Haliotis* species from Thailand, Andaman Sea (Gastropoda, Haliotidae). Of Sea and Shore 23:204-208.

Gaither, M.R., L.A. Rocha. 2013. Origins of species richness in the Indo-Malay-Philippine biodiversity hotspot: evidence for the centre of overlap hypothesis. Journal of Biogeography 40:1638-1648.

Geiger, D.L. 1998. Recent genera and species of the family Haliotidae Rafinesque, 1815 (Gastropoda: Vetigastropoda). The Nautilus 111:85-116.

Geiger, D.L. 1999. Description of *Haliotis fatui* new species (Gastropoda: Vetigastropoda) from the tropical western Pacific. The Nautilus 113:73-77.

Geiger, D.L., B. Owen. 2012. Abalone: Worldwide Haliotidae. Hackenheim: Conchbooks.

Lee, Y-H., V.D. Vacquier. 1995. Evolution and systematics in Haliotidae (Mollusca: Gastropoda): inferences from DNA sequences of sperm lysin. Marine Biology 124:267-278.

Lorenz, F. 2017. Cowries - a guide to the gastropod family Cypraeidae, Volume 1: biology and systematics. Hackenheim: Conchbooks.

Meyer, C.P. 2004. Toward comprehensiveness: increased molecular sampling within Cypraeidae and its phylogenetic implications. Malacologia 46:127-156.

Owen, B., A.D. Pan. 2016. An iconography of the Western Indian endemic abalone *Haliotis unilateralis* Lamarck, 1822 (Vetigastropoda: Haliotidae) with notes on its taxonomic history, distribution, ecology, and evolution. The Festivus 48:267-277.

Reeve, L.A. 1846. Descriptions of forty species of *Haliotis*, from the collection of H. Cuming, Esq. Proceedings of the Zoological Society of London 14:53-59.

Reeve, L.A. 1845. Conchologia Iconica, or, Illustrations of the shells of molluscous animals, Volume 3. London: Reeve, Brothers, King William Street, Strand.

Renema, W., D.R. Bellwood, J.C.Braga, K. **Bromfield, R. Hall, K.G. Johnson, P. Lunt, C.P. Meyer, L.B. McMonagle, R.J. Morley, A. O'Dea, J.A. Todd, F.P. Wesselingh, M.E.J. Wilson, J.M. Pandolfi. 2008.** Hopping hotspots: global shifts in marine biodiversity. Science 321:654-657.

Stewart, K.A., D.L. Geiger. 1999. Designation of lectoytpe for *Haliotis crebrisculpta* Sowerby, 1914, with a discussion of *H. clathrata* Reeve, 1846 (*non* Lichtenstein, 1794). The Veliger 42:85-96.

Streit, K., D.L. Geiger, B. Lieb. 2006. Molecular phylogeny and the geographic origin of Haliotidae traced by haemocyanin sequences. Journal of Molluscan Studies 72: 105-110.

Talmadge, R.R. 1962. The Linnanean *Haliotis varia* in Australia. Memoirs of the National Museum of Victoria 25:233-241.

Uiblein, F. 2011. Taxonomic review of Western Indian Ocean goatfishes of the genus *Mulloidichthys* (family Mullidae), with description of a new species and remarks on colour and body form variation in Indo-West Pacific species. Smithiana Bulletin 13:51-73.

Williams, S.T., T.F. Duda Jr. 2008. Did tectonic activity stimulate Oligo-Miocene speciation in the Indo-West Pacific? Evolution 62:1618-1634. doi: 10.1111/j.1558-5646.2008.00399.x.

Wilson, B. 2013. Patterns of life and the processes that produce them in: The biogeography of the Australian North West Shelf: environmental change and life's response. Perth: Elsevier, 268 –-371.

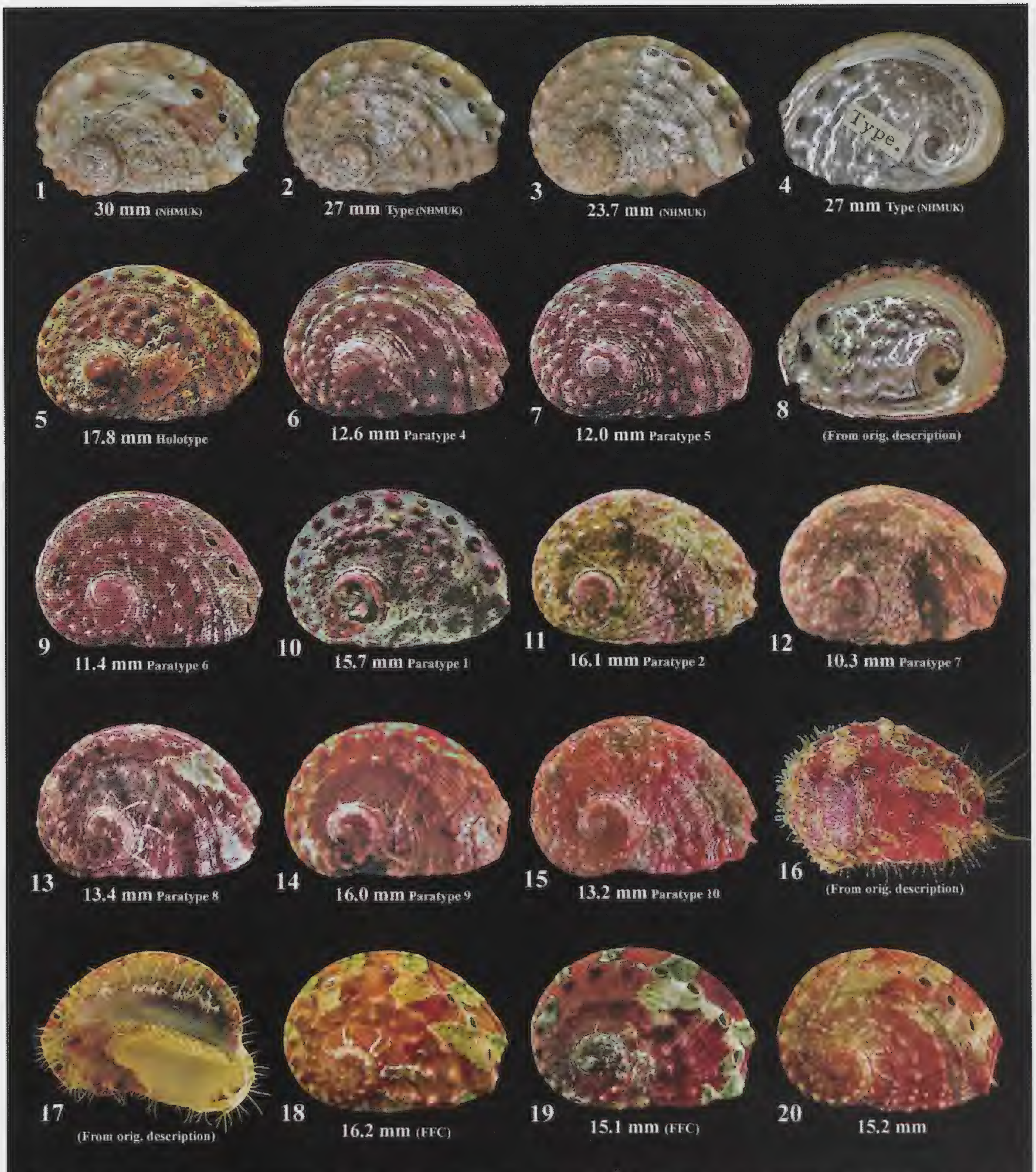


FIGURE 1: No. 1-4. *Haliotis papulata* Reeve, 1846. Syntypes. No. 5-15. *Haliotis thailandis* Dekker & Patamakanthin, 2001. Holotype and paratypes. No. 16-17. *H. thailandis* (living animal). No. 18-20. *H. papulata*. Racha Is., near Phuket, Thailand.

ISSN 0738-9388

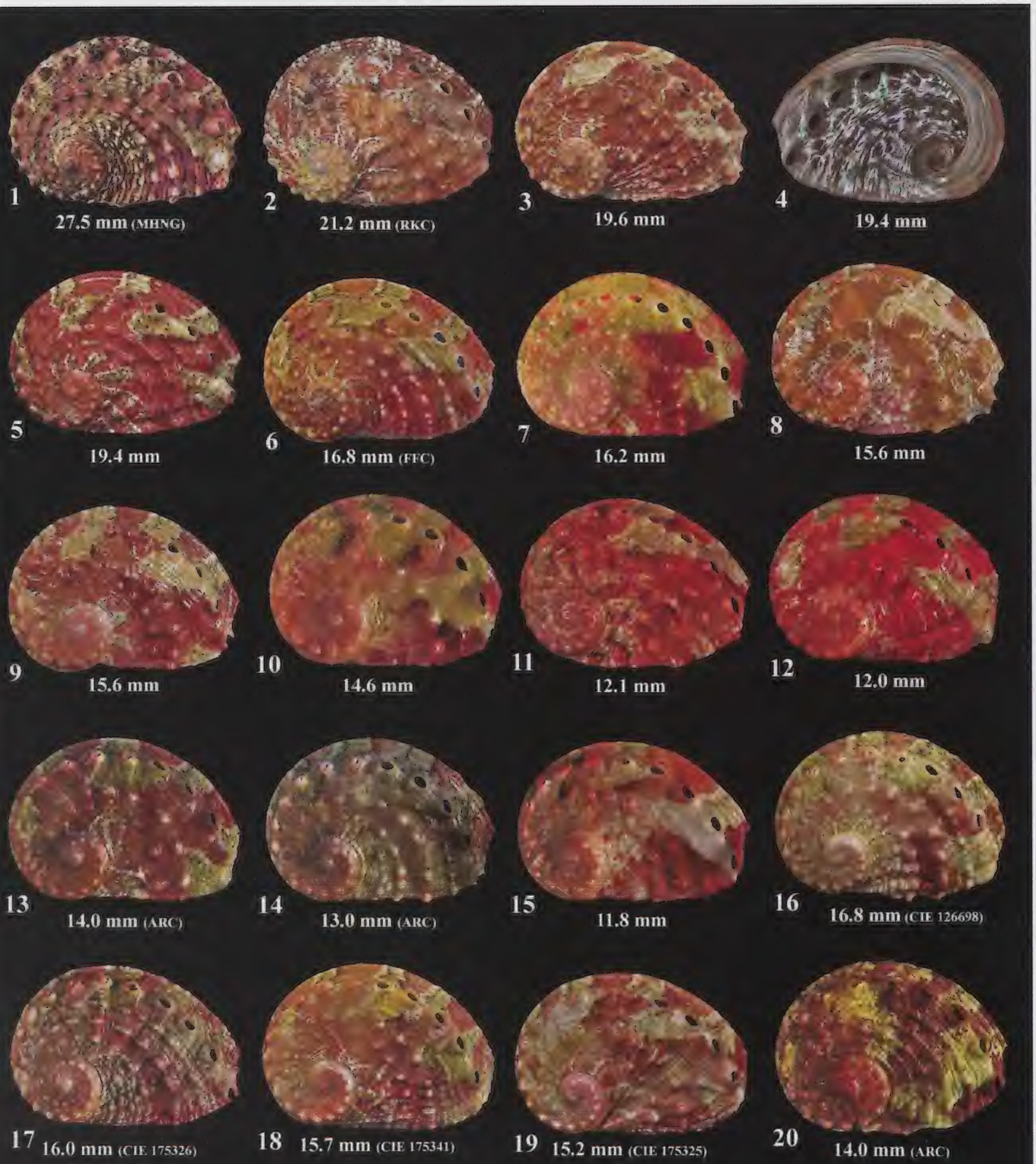


FIGURE 2: *Haliotis papulata* Reeve, 1846. No. 1. Aripo, Ceylon. No. 2-15. Racha Island, near Phuket, Thailand. No. 16-19. Olango Island, Philippines. No. 20. Near Milne Bay, Papua New Guinea (dead shell).

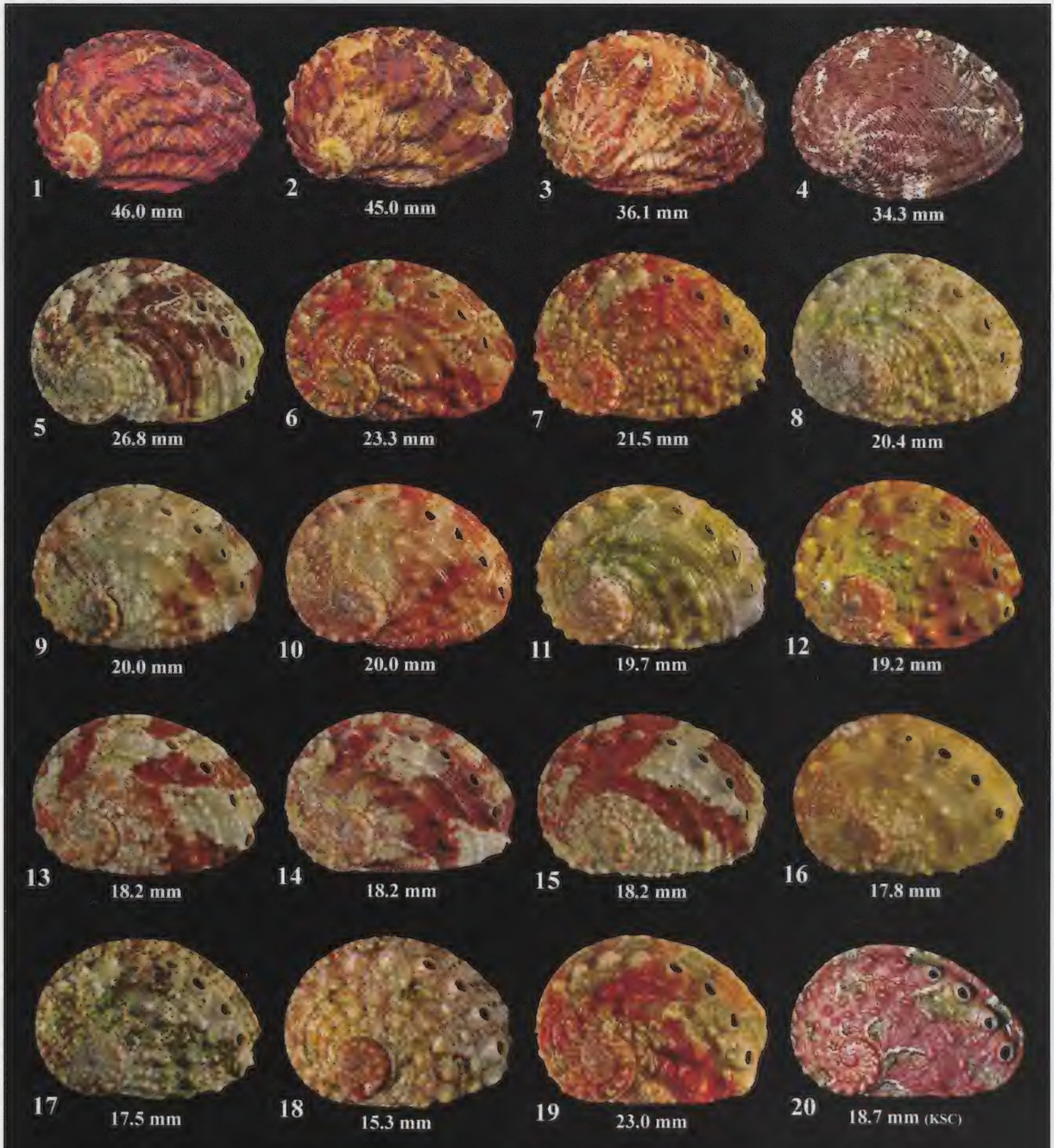


FIGURE 3: No. 1-4. *Haliotis varia* Linnaeus, 1758. Northern Territory, Australia. No. 5-18. *Haliotis unilateralis* Lamarck, 1822. Fernão Veloso, Nacala Bay, Mozambique. No. 19. *H. unilateralis*. Inhaca Island, Southern Mozambique. No. 20. *H. unilateralis*. Bassas da India.

ISSN 0738-9388

Volume: 51 THE FESTIVUS ISSUE 2

A New Scaphelline Volute from the Gulf of Mexico

Edward J. Petuch [1] and David P. Berschauer [2]
[1] Department of Geosciences, Florida Atlantic University, Boca Raton, Florida 33458
epetuch@fau.edu
[2] 25461 Barents Street, Laguna Hills, California 92653
shellcollection@hotmail.com

ABSTRACT A new subspecies of *Scaphella junonia* has been discovered off the Alacranes Reefs, along the northernmost edge of Campeche Bank, Yucatan Peninsula of Mexico. The new subspecies, here named *Scaphella junonia curryi*, differs from the other four known *S. junonia* subspecies in having the narrowest and most elongated shell, having the strongest and most extensive ribbed sculpture on the spire whorls, and in having a different color pattern composed of very large, almost fused rectangular spots. The new subspecies is confined to the edge of the Campeche Escarpment off the northern Campeche Bank islands and reefs.

KEY WORDS Volute, Volutidae, *Scaphella*, Scaphellinae, Campeche Bank, Alacranes Reefs, Yucatan Peninsula, Mexico

INTRODUCTION

An unusual and striking form of the widespread Carolinian Province *Scaphella junonia* has recently become available on commercial shell dealer's sales lists, with at least four specimens having come to our attention in recent months. These volutes were taken from an old collection and put up for resale, with most of the specimens having been collected in the 1970s. The senior author had seen similar shells, in the late 1960s, while attending school in Veracruz, Mexico, but these had been made into shell craft dolls by local curio vendors and were ruined as research specimens. After inquiring as to their origin, it was found that these unusual volutes had been taken by shrimpers working along the Campeche Bank fishing grounds, particularly in the vicinity of the Alacranes Reefs. This locality was recently corroborated by well-known Mexican diver and collector Andres Montes de Oca, who collected a freshly-dead specimen, occupied by a hermit crab, from 20 m depth off the Alacranes Reefs (Montes de Oca, personal communication). Over 50 years after its original discovery, there are now enough specimens, with accurate locality and bathymetric data, to be able to finally name this elusive animal, which is described in the following sections.

The holotype of the new subspecies of *Scaphella junonia* is deposited in the type collection of the Department of Malacology, Los Angeles County Museum of Natural History, Los Angeles, California and bears an LACM catalog number.

SYSTEMATICS

Class Gastropoda
Subclass Sorbeoconcha
Order Prosobranchia
Infraorder Neogastropoda
Superfamily Volutoidea
Family Volutidae
Subfamily Scaphellinae
Genus *Scaphella* Swainson, 1832
Species *Scaphella junonia* (Lamarck, 1804)

Scaphella junonia curryi Petuch and Berschauer, new subspecies
(Figure 1 A-F)

Description. (Described as a subspecies of *Scaphella junonia*) Shell proportionally very elongated for species, with long, narrow body and high, elevated spire; early whorls of spire with angled shoulders; shell base color pale orange or yellow-orange, overlaid with 8-11 rows of proportionally very large reddish-brown rectangular checkers, which often fuse with adjacent checkers to form larger elongated rectangles; some specimens with rectangles coalescing into almost solid bands, forming rectilinear network of thin yellow-orange lines superimposed upon solid reddish-brown background (Figure 1 A); spire whorls yellow-orange, marked with 2 rows of large, closely-packed checkers; aperture proportionally narrow, slightly arcuate, colored pale cream-white within interior; calcarella only slightly pointed, dome-like, composed of 2 whorls; first 3 whorls of teleoconch heavily ornamented with strong, closely-packed longitudinal ribs.

Type Material. HOLOTYPE - Length 101.2 mm, width 37.9 mm, Trawled form 30 m depth off the Alacranes Reefs, Campeche Bank, Mexico, LACM 3656 (Figure 1 C, D); **OTHER MATERIAL EXAMINED** - length 107.8 mm, same locality and depth as the holotype, in the Berschauer Collection (Figure 1 E, F); length 99.5 mm, same locality and depth as holotype, in the Petuch Collection (Figure 1 A, B).

Type Locality. The type lot of *Scaphella junonia curryi* was trawled from 30 m depth north of the Alacranes Reefs, along the Campeche Escarpment, Campeche Bank, Yucatan Peninsula, Mexico.

Distribution. At present, known only from north of the Alacranes Reefs, but may be present off other island groups along the Campeche Escarpment of the northern Campeche Bank, such as Cayo Arenas, Bancos Ingleses, and Cayos Arcos.

Ecology. The new Campeche Bank subspecies is found on carbonate mud and shell fragment sediments, in depths of 20-50 m. There it occurs together with the large marginellid *Prunum labiatum* (which is often dredged by the thousands) and the busyconid *Busycoarctum coarctatum*.

Etymology. Named for Gregory Curry of Key West, Florida, volute specialist and one of the regional authorities on the family Volutidae.

Discussion. The Juno's Volute, *Scaphella junonia* (Lamarck, 1804), is now known to encompass a cluster of biogeographically-discrete subspecies. These include:

1. *Scaphella junonia junonia* (Lamarck, 1804) (the nominate subspecies; Figure 2 A, B), which ranges throughout the entire Carolinian Province, from Cape Hatteras, North Carolina south to the Florida Keys and throughout the entire Gulf of Mexico.

2. *Scaphella junonia elizabethae* Petuch and Sargent, 2011, (Figure 2 G, H), which ranges all along the Florida Keys and Dry Tortugas and is associated with living coral reefs.

3. *Scaphella junonia johnstoneae* Clench, 1953 (Figure 2 C, D), which ranges along the Florida Panhandle from Apalachicola westward to Mississippi.

4. *Scaphella junonia butleri* Clench, 1953 (Figure 2 E, F), which ranges all along the Yucatan Peninsula area, from Tabasco State to Quintana Roo State, Mexico.

5. *Scaphella junonia curryi* Petuch and Berschauer, new species (Figure 1 A-F), restricted to the edge of the Campeche Escarpment off the Alacranes Reefs, Campeche Bank, Mexico.

The biogeographical ranges of the five subspecies of *Scaphella junonia* are shown here on Figure 3. With the exception of the wide-ranging and nearly ubiquitous *Scaphella junonia junonia*, all of the other subspecies are restricted to small geographical areas and are genetically isolated from one another. These five taxa also represent the only living members of *Scaphella sensu stricto*, as all of the other "*Scaphella*" species found in the Carolinian and Caribbean Provinces belong to the subgenera (or possibly full genera) *Clenchina*, *Aurinia*, *Rehderia*, and *Caricellopsis* (see Clench, 1953; Petuch and Sargent, 2011; Petuch, 2013; and Petuch and Myers, 2014).

The new subspecies, *Scaphella junonia curryi*, differs from all of the other known *junonia* subspecies in having a narrower and more elongated shell with a proportionally higher spire and larger color spots. Only *S. junonia johnstoneae* (Figure 2 C, D), with its high spire and pale orange base color, is similar to the new Alacranes Reef subspecies. The northern Gulf of Mexico *junonia johnstoneae*, however, differs greatly in the form of the color pattern, having 13-14 rows of small dark brown rectangular spots. *Scaphella junonia curryi*, on the other hand, has 8-11 rows of large reddish-brown checkers that often coalesce to form closely-packed bands of nearly-interconnected rectangles (see Figure 1 A). The new Alacranes Reef subspecies differs from the other four subspecies in having the most heavily-sculptured early whorls, exhibiting strong longitudinal ribs on the first three whorls of the teleoconch.

The nominate subspecies, *Scaphella junonia junonia*, ranges throughout the Carolinian Province but varies greatly in its bathymetric range. Along the eastern coast of the United States, *S. junonia junonia* is found in offshore areas, at depths of around 50 m, often associated with shoals of the large scallop *Argopecten gibbus carolinensis* (Petuch, 2013). Farther south along the Florida Keys, the nominate subspecies follows a bathymetric submergence pattern, occurring at depths of over 100 m and inhabiting a very narrow strip of continental shelf around the periphery of the Keys archipelago (Figure 3). North of the Florida Keys, *S. junonia junonia* comes closer to shore and is frequently found at depths of less than 20 m. At some western Florida localities, such as Marco Island and Sanibel Island, the nominate subspecies lives so close to the shoreline that it is regularly washed ashore after storms. Farther north along the Florida coast and throughout the rest of the Gulf of Mexico, the nominate subspecies again submerges into deeper water, occurring at depths of 60-100 m and sometimes deeper. Along the Yucatan Peninsula *S. junonia junonia* is rare and appears to prefer depths of over 100 m, well below the fishing depth of most shrimpers.

Although the subspecies *S. junonia elizabethae*, *S. junonia johnstoneae*, and *S. junonia butleri* occur within the range of *S. junonia junonia* (Figure 3), they are not sympatric and occur in much shallower water than does the nominate subspecies. These subspecific taxa, then, represent bathymetric subspecies of *S. junonia junonia*, with each having become genetically isolated from its ancestral stock by having developed different depth preferences. Both *S. junonia elizabethae* and *S. junonia butleri* have moved into shallow carbonate coral reef areas (5-25 m depths) and are both components of the fore reef community of the Florida Keys and Campeche Bank reef systems. The new subspecies, *S. junonia curryi*, prefers depths of 30-50 m and is bathymetrically intermediate between the depth preferences of *S. junonia junonia* (100+ m) and *S. junonia butleri* (5-25 m). For this reason, the northern edge of the Campeche Bank, with its stepped submarine terraces, is the only area within the Carolinian Province where three bathymetric subspecies of *S. junonia* can occur in near proximity (Figure 3). Each subspecies is actually living on its own isolated terrace level and is reproductively isolated from its sister taxa in shallower or deeper water.

ACKNOWLEDGMENTS

We thank Andres Montes de Oca, Merida, Yucatan, Mexico, for sharing his biogeographical and ecological data about the new subspecies.

REFERENCES

Clench, W.J. 1953. The Genera *Scaphella* and *Aurinopsis* in the Western Atlantic. *Johnsonia* 2(32):376-380.

Petuch, E.J. 2013. Biogeography and Biodiversity of Western Atlantic Mollusks. CRC Press, London, New York, Boca Raton. pp. 31-74.

Petuch, E.J. and R.F. Myers. 2014. Molluscan Communities of the Florida Keys and Adjacent Areas: Their Ecology and Biodiversity. CRC Press, London, New York, Boca Raton. 209 pp.

Petuch, E.J. and D.M. Sargent. 2011. Rare and Unusual Shells of the Florida Keys and Adjacent Areas. MdM Publishing, Wellington, Florida. 158 pp.

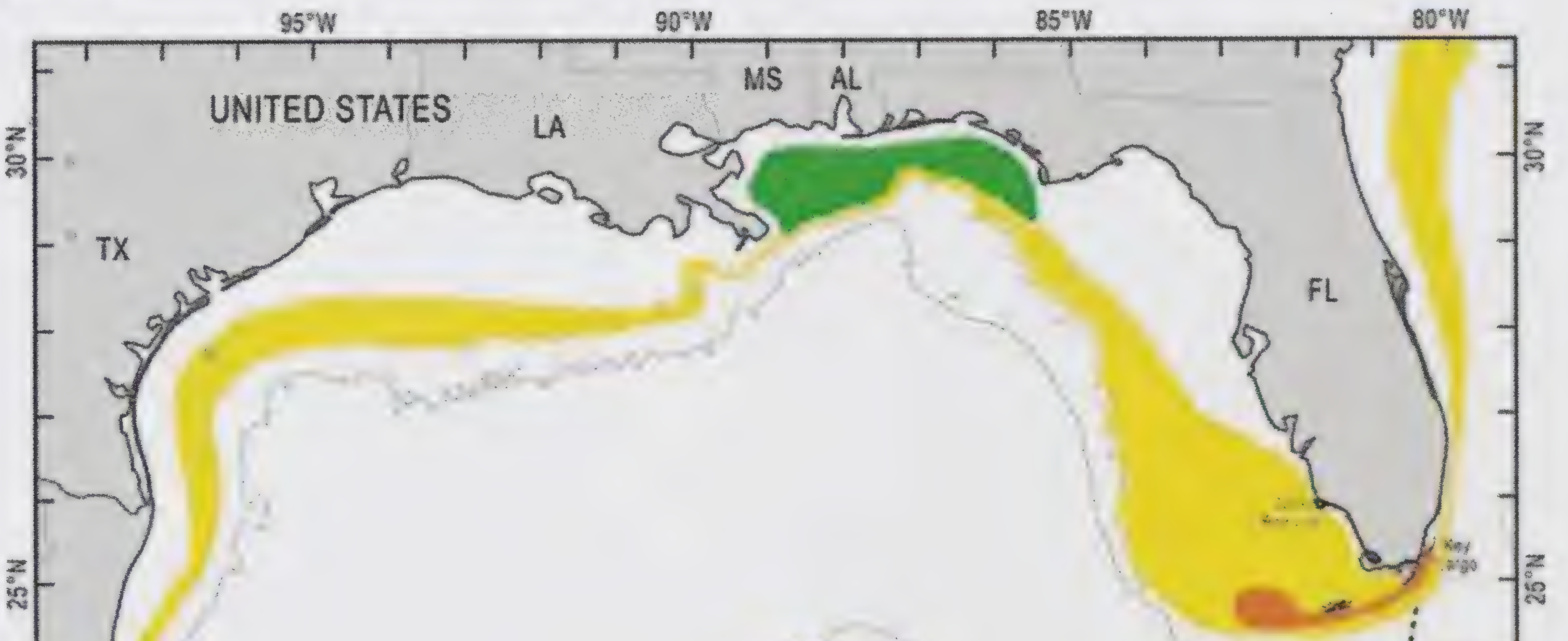


Figure 3. Map Showing the Distributions of the Five Subspecies of *Scaphella junonia*. Yellow= *Scaphella junonia junonia*; **Orange=** *Scaphella junonia elizabethae*; **Green=** *Scaphella junonia johnstoneae*; **Blue=** *Scaphella junonia butleri*; **Red=** *Scaphella junonia curryi*.

ISSN 0738-9388

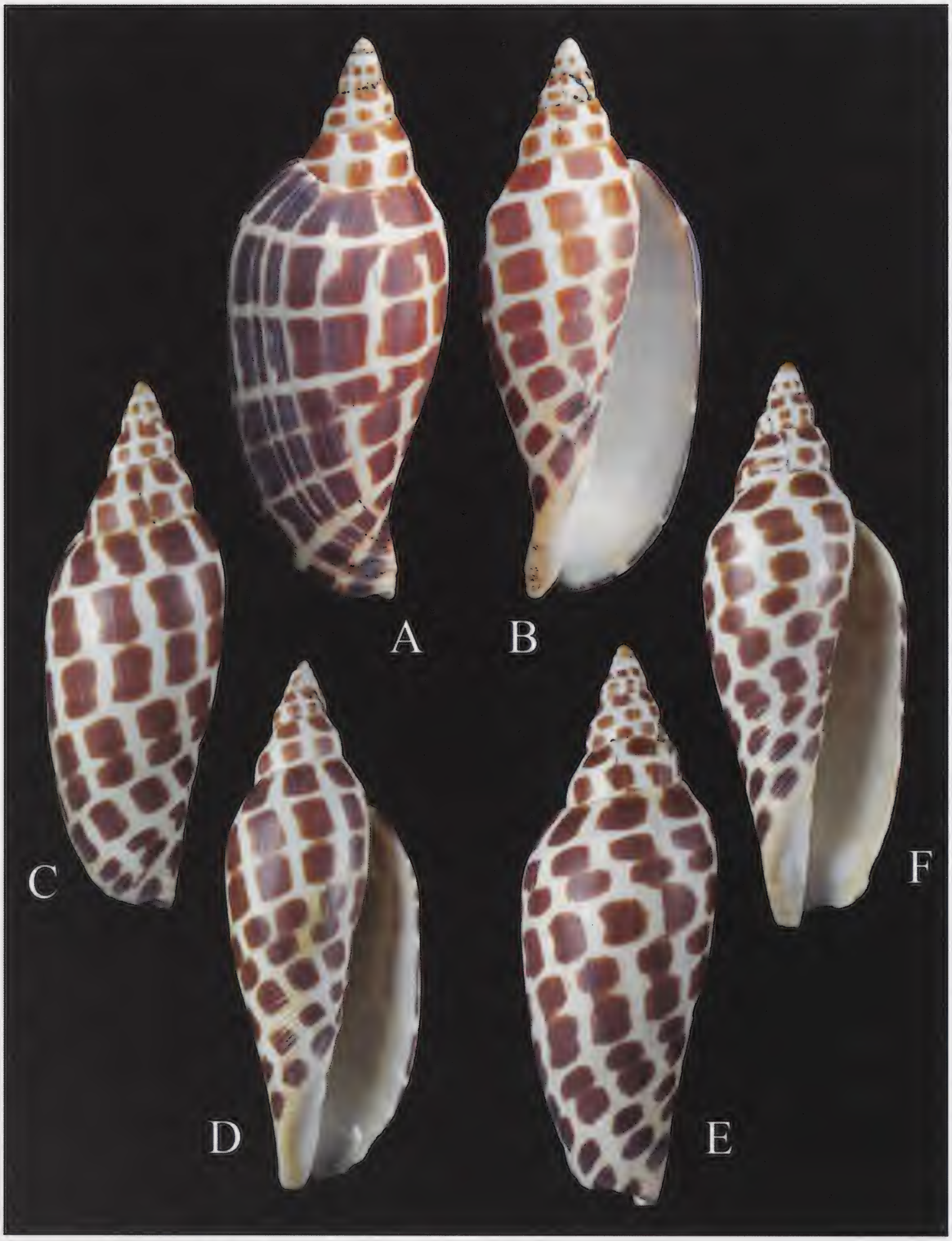


Figure 1. ***Scaphella junonia curryi*** **Petuch and Berschauer, new subspecies.**
A, B= Length 99.5 mm, in the Petuch Collection; **C, D=** Holotype, length 101.2 mm, LACM 3656; **E, F=** Length 107.8 mm, in the Berschauer Collection. All specimens were trawled from 30 m depth by shrimpers, north of the Alacranes Reefs, Campeche Bank, Mexico.

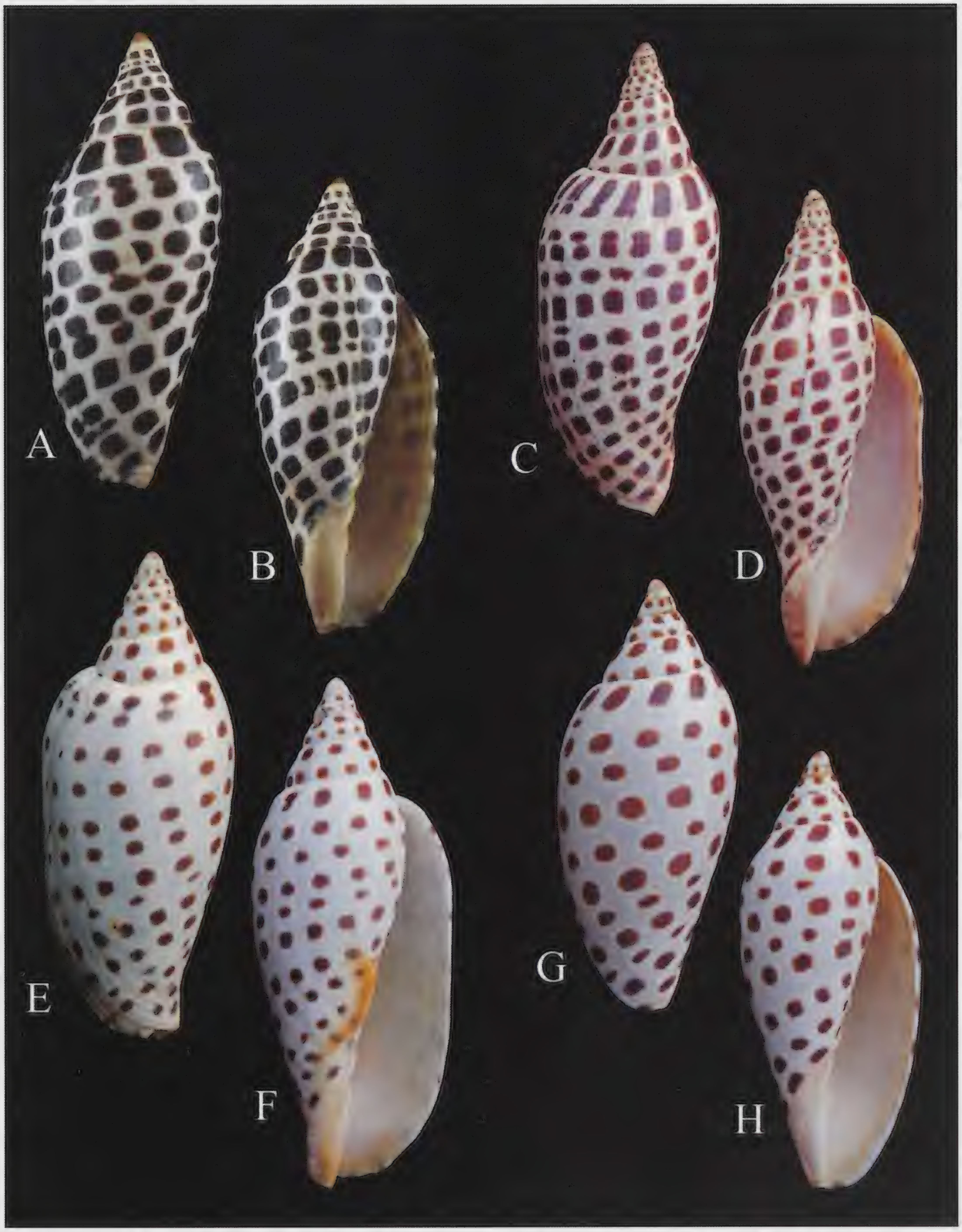


Figure 2. Subspecies of *Scaphella junonia* (Lamarck, 1804) from the Eastern United States and Gulf of Mexico.
A, B= *Scaphella junonia junonia* (Lamarck, 1804), length 112 mm, collected in a crab trap set in 20 m depth, 10 km northwest of Rabbit Key, Ten Thousand Islands, Monroe County, Florida; **C, D=** *Scaphella junonia johnstoneae* Clench, 1953, length 117 mm, trawled by shrimpers from 25 m depth, 50 km south of Dauphin Island, Alabama; **E, F=** *Scaphella junonia butleri* Clench, 1953, length 119 mm, trawled by shrimpers from 25 m depth north of Serpiente Reef, Campeche Bank, off Sisal, Mexico; **G, H=** *Scaphella junonia elizabethae* Petuch and Sargent, 2011, length 113 mm, collected by diver from 20 m depth off Garden Island, Dry Tortugas, western Florida Keys.

ISSN 0738-9388

Volume: 51 THE FESTIVUS ISSUE 2

A new species of *Placiphorella* (Polyplacophora: Mopaliidae) from the North American Pacific coast

Roger N. Clark
Research Associate: Santa Barbara Museum of Natural History, 2559 Puesta Del Sol, Santa Barbara, CA 93105. Email: insignis69@gmail.com

ABSTRACT A new deep-sea chiton of the genus *Placiphorella* Dall, 1879, *Placiporella laurae* n. sp. is described from the Pacific coast of North America. It is compared with its congener *Placiphorella pacifica* Berry, 1919, from which it differs primarily by having granular valves, lacking false beaks, a papillose girdle, and the characteristics of its girdle spicules.

KEY WORDS Polyplacophora, Chiton, *Placiphorella*, *Placiporella laurae* n. sp.

INTRODUCTION

White shelled, bathyal (*i.e.* 200-2,000+ m) chitons of the genus *Placiphorella* Dall, 1879 were once believed to represent a single cosmopolitan species, *Placiphorella atlantica* (Verrill & S.I. Smith, in Verrill, 1882) (Kaas & van Belle, 1994; Clark, 1994). Saito *et. al.* (2008), revived *P. pacifica* Berry, 1919 and *P. albitestae* I. Taki, 1954 as distinct from *P. atlantica*, described two new species with similar morphology from thermal vents: *P. isaotakii* Saito, Fujikura & Tsuchida, 2008, *P. okutanii* Saito, Fujikura & Tsuchida, 2008, and also briefly characterized a still-undescribed species from Madagascar. Likewise, Schwabe and Sellanes (2010) briefly described, but did not name, a putative new species from southern Chile, and Irisarri *et al.* (2014) published sequences of a likely new species, referred to as *Placiphorella* sp. A, from seamounts off southern California at 551-1,412 m depth, and this species is currently under study by D.J. Eernisse and A. Draeger (D.J. Eernisse, *in litt.* 19 April 2019). The author is also aware of two other likely undescribed species, one from Alaska, and one from the sub-Antarctic region (RNC personal notes), but the latter has not yet been sufficiently compared with those from Madagascar or Chile.

The presently described species is similar to *P. pacifica,* with which it is sympatric, but differs in the granular tegmentum, lack of a false beak on the intermediate valves, and papillose surface of the girdle (mantle).

Abbreviations used in the text.
CASIZ, California Academy of Sciences, Invertebrate Zoology.
LACM, Los Angeles County Museum of Natural History.
NMFS, National Marine Fisheries Service.
NOAA, National Oceanic and Atmospheric Administration.
RNC, Roger N. Clark, Personal Reference Collection.
SBMNH, Santa Barbara Museum of Natural History.

SYSTEMATICS

Class: Polyplacophora
Subclass: Neoloricata
Order: Chitonida
Suborder: Acanthochitonina
Superfamily: Moplaioidea
Family: Mopaliidae Dall, 1889

Genus: *Placiphorella* Dall, 1879
Type (OD): *P. velata* (Carpenter MS, Dall, 1879)

Placiphorella laurae Clark, new species
(Figure 1 A-I, L-M)

Placiphorella pacifica A.G. Smith & Hanna, 1952, *non P. pacifica* Berry, 1919;
Placiphorella "pacifica" Saito, *et. al.*, 2008.

Type locality. Off Del Norte Co., California (41°41.96 N, 125°00.73 W), 855 m. (NMFS 21-200101-106) (ex RNC 2178).

Type material. Holotype (ethanol), SBMNH 169025, 45 mm. (*leg.* RNC, 23 October, 2001); trawled R/V Miller Freeman, 855 m; Paratype 1 (glycerin dried), LACM 3336, 29 mm; Paratype 2 (ethanol), 31 mm & Paratype 3 (glycerin dried), 44 mm RNC 2178. All types from the type locality.

Referred material. 1, CASIZ 064802, 25 mm. Pioneer Seamount, off San Mateo Co., California (37°24.4 N, 123°23.5 W), trawled, 650 m; 2, RNC 2012, 42 & 38 mm. Off Curry Co., Oregon (42°31.56 N, 124°53.66 W); trawled R/V Miller Freeman, 1186 m. (NMFS 21-199513-27); 1, RNC 2013, 46 mm. Off Clallum Co., Washington (48°N); F/V Sea Blazer, trawled 850 m (ex William Ritter); 1, RNC 2014, 32 mm. Monterey Sea Canyon (36°45.16 N, 122°03.44 W), trawled R/V Point Sur, 650 m. (*leg.* RNC, 21 October, 1998).

Diagnosis. Animal relatively large (to 4.5 cm), broadly oval; girdle expanded anteriorly, perinotum with spinose setae; valves depressed, carinated, granular (often faintly), not false beaked, tail valve triangular with strong marginal ribs.

Description. Mopaliid chiton of moderate size, to 4.5 cm in length, including girdle (Holotype, 4.5 cm) (Figure 1 A, B); body broadly oval in outline; Valves depressed, carinated, short, broad, tegmentum minutely (often obsoletely) granular, particularly on terminal valves and lateral areas of intermediate valves; uniformly white in color. Girdle broadly expanded anteriorly, rather coarsely papillose dorsally and ventrally; uniformly white or cream in color.

Valves: Head valve (Figure 1 C) only moderately crescentic, (Holotype) 19 x 3.5 mm, with 8 weak radial sulci; insertion teeth low, thick, blunt 22 in number due to irregular splitting of 10 primary teeth, slit rays obsolete; Intermediate valves (Figure 1 D) much broader than long (valve V, 25.6 mm x 5 mm), lateral areas raised, sharply defined by flattened diagonal and marginal ribs separated by a weak, medial sulcus, sutural laminae well developed, separated by broad jugal sinus, insertion teeth one (sometimes two due to splitting) per side, slit rays obsolete; Tail valve (Figure 1 E) broadly triangular, 11.1 x 4 mm, mucro terminal; ante-mucronal area concave; margins sharply thickened, rib-like; sutural laminae well developed, straight along anterior edge, jugal sinus relatively wide; insertion teeth lacking.

Girdle: Perinotum (dorsal surface) densely covered with low, irregular papillae to 1 mm in diameter, and profusely scattered slender, white spicules, in groups of 1-3+, to 400 x 25 µm (Figure 1 F), and scattered slender setae (Figure 1 G) to 2 mm in length, bearing slender spicules 400 x 25 µm; margin of girdle with 2-3 alternating rows of short, thick spinose bristles (Figure 1 H) to 3 mm in length, bearing spicules to 350 x 40 µm. Hyponotum (ventral surface) densely covered with low round papillae to 500 µm, disposed in irregular radial series, and scattered spicules to 150 x 30 µm, in groups of 1-3, mostly between papillae. Pallial fold well developed, modified anteriorly, into pre-cephalic feeding tentacles; 4-5 primary and 3-5 secondary tentacles.

Ctenidia: holobranchial, abanal, 18/17 per side in holotype.

Radula: (Figure 1 I) Rachidian tooth near rectangular, about 145 µm in length, working edge 60 µm in width, slightly wider near the base; minor laterals sub-triangular, 125 µm in length and about 50 µm at the base; major laterals, relatively large, about 300 µm in length, head tri-cuspid about 90 µm x 90 µm, denticles about equal in length, sharply pointed.

Paratypes. Paratypes agree well with the holotype in all major characters, but there are some minor variations in the granulation of the tegmentum, and the hirsuteness of the girdle, larger specimens tending to be more hirsute.

Remarks. *Placiphorella laurae* n. sp. differs from the similar and sympatric *Placiphorella pacifica* (Figure 1 J, K), in: (1) the (often nearly obsolete) granulation of the tegmentum (the tegmentum of *P. pacifica* is smooth); (2) false beaks on intermediate valves lacking; (3) jugal laminae lacking; (4) triangular, pointed tail valve with concave ante-mucronal slope (the ante-mucronal slope in *P. pacifica* is convex); and (5) numerous tufts or groups of spicules on the girdle.

Placiphorella laurae n. sp. Also resembles *Placiphorella okutanii*, from near hydrothermal vents in the South China Sea, south of Japan, but differs in: (1) the carinated valves; (2) less granular tegmentum; (3) less crescentric head valve; and (4) the thick marginal rib of the tail valve that extends to the anterio-lateral corner.

In addition to these described species, at least three other as yet undescribed species are known, one from Alaska, one from the sub-Antarctic region (RNC, personal observation), and one from near Madagascar (Saito, *et. al.*, 2008).

Members of the genus *Placiphorella* are unusual among chitons, in that they capture active prey. This behavior is also known as a probable case of convergent evolution in two other genera in completely separate families (Eernisse, 2007), but it was first observed in *Placiphorella* by McLean (1962), in *P. velata*. I have observed this feeding behavior in *P. velata, P. pacifica,* and *P. rufa* Berry, 1917 (personal observation). Like its congeners, *P. laurae* n. sp. is undoubtedly an ambush predator as inferred from the expanded anterior girdle and pre-cephalic tentacles.

Distribution. (Figure 1 M), Juan de Fuca Sea Canyon, off Clallum County, Washington (48°N), to Monterey Sea Canyon, Monterey County, California (36°45 N), at bathyal depths of 650 to 1,186 m, on boulders.

Etymology. It is with great pleasure that I name this chiton in honor of my dear friend Mrs. Laura Burghardt of Oakdale California, co-author (with her husband Glenn) of the book West Coast Chitons (Burghardt, 1969), which served as "The" primary identification guide for chitons for many years and inspired generations of chiton collectors and researchers.

ACKNOWLEDGMENTS

Special thanks to the following: Robert R. Lauth, Alaska Fisheries Science Center, NOAA/NMFS (Seattle, Washington); Daniel L. Geiger (for SEM images), and Henry Chaney, Santa Barbara Museum of Natural History; Lindsey Groves, Los Angeles County Museum of Natural History; and the Captain and crew of the NOAA research vessel Miller Freeman.

William Ritter, Astoria, Oregon. The comments of two anonymous reviewers were invaluable.

REFERENCES

Burghardt, G.E. & L.E. Burghardt. 1969. A Collectors Guide to West Coast Chitons. Special publication No. 4. San Francisco Aquarium Society, Inc., Golden Gate Park, San Francisco, California.

Clark, R.N. 1994. Review of the genus *Placiphorella* Dall, 1879, ex Carpenter MS (Polyplacophora: Mopaliidae) with descriptions of two species. The Veliger 37(3):290-311.

Eernisse, D.J. 2007. Chitons. pp. 127-133, in: Encyclopedia of Tidepools and Rocky Shores. M.W. Denny and S.D. Gaines (Eds.) University of California Press, Berkeley, California.

Irisarri, I., D.J. Eernisse & R. Zardoya. 2014. Molecular phylogeny of Acanthochitonina (Mollusca: Polyplacophora: Chitonida): three new mitochondrial genomes, rearranged gene orders and systematics. Journal of Natural History, 48:2825-2853.

Kaas, P. & R.A. Van Belle. 1994. Monograph of Living Chitons, Vol. 5, Suborder Ischnochitonina: Ischnochitonidae (concluded), Callistoplacinae; Mopaliidae; Additions to Volumes 1-4. E. J. Brill, Leiden, The Netherlands.

McLean, J.H. 1962. Feeding behavior of the chiton *Placiphorella*. Proceedings of the Malacological Society of London 35:23-36.

Saito, H., K. Fujikura & S. Tsuchida. 2008. Chitons (Mollusca: Polyplacophora) associated with hydrothermal vents and methane seeps around Japan, with descriptions of three new species. American Malacological Bulletin 25:113-124.

Schwabe E. & J. Sellanes. 2010. Revision of Chilean bathyal chitons (Mollusca: Polyplacophora) associated with cold-seeps, including description of a new species of *Leptochiton* (Leptochitonidae). Organisms, Diversity & Evolution. DOI 10.1007/s13127-009-0002-6.

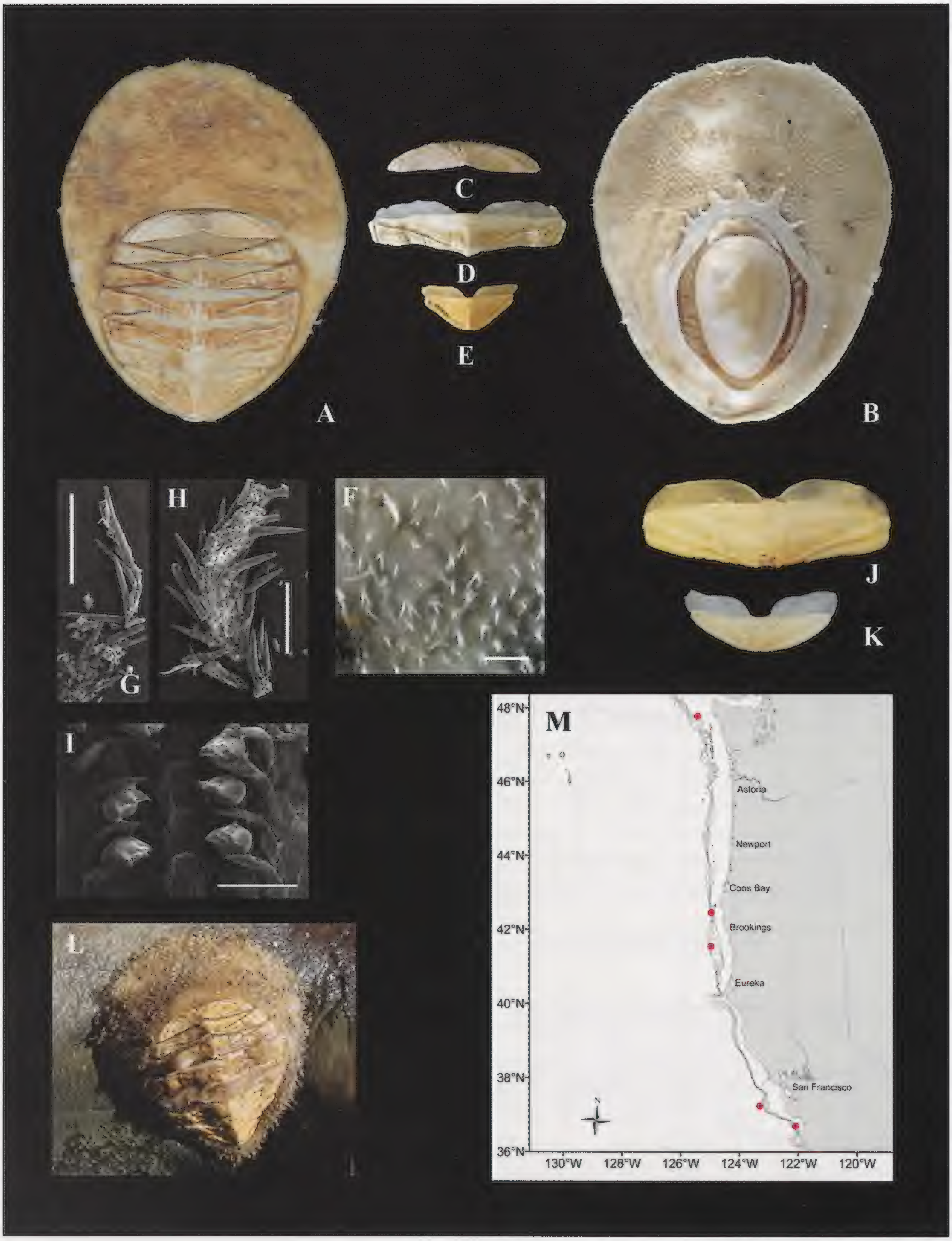
Smith, A.G. & G.D. Hanna. 1952. A rare chiton from Pioneer Seamount off central California. Proceedings of the California Academy of Sciences (fourth Series) 27(14):389-392.

FIGURE CAPTION: (see Figure on next page)

Figure 1. *Placiphorella laurae* n. sp. compared with *P. pacifica*. A-I, L = *Placiphorella laurae* n. sp. Holotype: SBMNH XXXXX. **A**, whole animal (dorsal), 45 mm; **B**, whole animal (ventral), 45 mm; **C**, head valve, 19.0 mm; **D**, intermediate valve 5, 25.6 mm; **E**, tail valve, 11.1 mm; **F**, Perinotum, bar = 1 .0 mm; **G**, slender dorsal setae, bar = 400 µm; **H**, marginal bristle, bar = 350 µm; **I**, radula, scale bar = 200 µm; **L**, living animal, in situ.

J-K = *Placiphorella pacifica*, RNC 2016, SW of Tanaga Island, Aleutian Islands, Alaska; trawled, 168 m; **J**, intermediate valve 5, 21.0 mm; **K**, tail valve, 11.0 mm.

M = *Placiphorella laurae* Distribution, West coast of North America, Juan de Fuca Strait, Washington to Monterey Bay, California. Depth curves, 600, 800, 1000, and 1200 m; *P. laurae* (red circles on map =●).


A
B
C
D
E
F
G
H
I
J
K
L
M
48°N
46°N
44°N
42°N
40°N
38°N
36°N
130°W
128°W
126°W
124°W
122°W
120°W
Astoria
Newport
Coos Bay
Brookings
Eureka
San Francisco
N

ISSN 0738-9388

Two New species of *Amphidromus* (Gastropoda: Camaenidae) from Vietnam

Nguyen Ngoc Thach
Former Research Associate, Oceanographic Institute
Nha Trang, Vietnam
Thachshells267@yahoo.com

ABSTRACT Two new species of genus *Amphidromus* Albers, 1850 are described from Vietnam and compared to five other species of this genus: *Amphidromus koenigi* Thach & Huber, 2018, *Amphidromus laii* Thach, 2019, *Amphidromus inconstans* Fulton, 1898, *Amphidromus kaloensis* Fulton, 1896 and *Amphidromus bernardfamyi* Thach, 2017.

KEYWORDS Gastropoda, Helicoidea, Camaenidae, *Amphidromus*, Đắk R'lấp, Đắk Nông, Ea H'leo, Đắk Lắk, Vietnam, new taxon

INTRODUCTION

Amphidromus is a genus of the family Camaenidae with many species collected in Vietnam. In January 2019, two other species of this genus were collected. They were not listed in the works by Parkinson, Hemmen & Groh (1987), Abbott (1989), Dharma (2005), Van der Bijl *et al.* (2010), Stanisic, Shea, Potter & Griffiths (2010, 2017), Schileyko (2011), Tan *et al.* (2011), Parsons (2014), Raheem *et al.*,2014, Sutcharit *et al.* (2015), Inkhavilay *et al.* (2017), Lok & Tan (2018), Thach (2005, 2007, 2012, 2016, 2017, 2018). In this article, they are described as new to science.

Abbreviations.

MNHN	National Museum of Natural History, Paris, France
NHMUK	Natural History Museum, London, UK
NNT	Collection Dr Thach
HA	Ex-collection Huynh Anh
SH	Shell height
SW	Shell width
BH	Body whorl height
AH	Aperture height

SYSTEMATICS

Class Gastropoda Cuvier, 1797
Superfamily Helicoidea Rafinesque, 1815
Family Camaenidae Pilsbry, 1895
Subfamily Camaeninae Pilsbry & Olsson, 1954
Genus *Amphidromus* Albers, 1850
Type species of genus: *Helix perversus* Linnaeus, 1758

Amphidromus philippeboucheti Thach, 2019
new species
(Figures 1-8)

Description. Shell small for the genus (measuring in average height between 24.2 mm and 34.0 mm), sinistral and elongate tapering in shape with width 53.3% of height (see Table 1). Spire moderately tall, sutures deep. Body whorl inflated and measuring 67% of shell height, periphery rounded. Outer surface ornamented with two black spiral bands at base and many sets of widely-spaced axial lines that are rather straight and parallel. Sculpture consists of weak axial striae. Aperture wide with external pattern visible within, occupying 47.8% of shell height, outer lip moderately thick, slightly reflected and regularly convex. Umbilicus slightly open, columella curved and bordered by red band. Color yellow with pink outer lip and columella, black apex and axial lines, carmine red subsutural bands.

No	1	2	3	4
SH (mm)	24.2	27.5	30.6	34.0
SW (mm)	13.3	15.4	16.6	16.3
SW/SH	0.55	0.56	0.54	0.48
Mean SW/SH	**0.53**			
AH (mm)	11.0	13.8	15.1	16.0
AH/SH	0.45	0.50	0.49	0.47
Mean AH/SH	**0.48**			
BH (mm)	16.0	18.3	20.8	22.9
BH/SH	0.66	0.67	0.68	0.67
Mean BH/SH	**0.67**			

Table 1. Morphometrics of *Amphidromus philipeboucheti* Thach, 2019.

Diagnosis. The new species is characterized by carmine red subsutural bands, pink outer lip and columella, widely-spaced black axial stripes that are rather straight and consists of three parallel lines.

Type material.
HOLOTYPE 24.2 mm high (Figures 1, 2, 3, 4, 5, 8a) in MNHN with Registration No: MNHN-IM-2000-34687.

Other Material Examined.
Paratypes: all from type locality, Paratype 1, 27.5 mm (Figures 6, 7, 8b); Paratype 2: 30.6 mm and Paratype 3: 34.0 mm in NNT (not illustrated).

Type Locality. Đắk R'lấp District, Đắk Nông Province, Central Vietnam.

Habitat. Around trees, among leaf litter.

Etymology. This new species is named in honor of Prof. Philippe Bouchet of France for his great contribution to the development of malacology.

Discussion. The new species is close to *Amphidromus koenigi* Thach & Huber, 2018 (Figure 9, 10) in two black spiral bands at base, carmine red subsutural bands and aperture with external pattern visible within but differs mainly in absence of turmeric yellow spiral band and presence of series of parallel axial lines. *Amphidromus laii* Thach, 2019 (Figures 11, 12) is distinguished mainly from the new species in smaller adult size, absence of axial stripes at body whorl, translucent white (not pink) outer lip and columella.

Amphidromus huynhi Thach, 2019
new species
(Figures 13-20)

Type material.
Holotype 29.5 mm in MNHN (Figures 13-17) with Registration No: MNHN-IM-2000-34686. Paratype 1: 31.2 mm (Figures 18-20) from type locality, in HA.

Type locality. Ea H'leo District, Đắk Lắk Province, Central Vietnam.

Habitat. Around trees.

Diagnosis. The new species is characterized by small adult size, straight-sided spire and narrow black bars arranged into widely-spaced spiral bands.

Description. Shell small for the genus (measuring in height between 29.5 mm and 31.2 mm), elongate ovate in outline with sinistral coiling. Spire moderately low, sutures slightly constricted. Body whorl inflated and measuring 65.1% of shell height in holotype, periphery rounded. Shell width 47.1% of height, outer surface ornamented with intermittent, widely spaced spiral bands. Sculpture consists of red (or black) subsutural bands and weak axial riblets that are strongest at dorsal side of body whorl, along the reflected outer lip. Aperture elongate-ovate, occupying 46.1% of shell height in holotype with external pattern visible within, outer lip moderately thick, calloused and slightly reflected. Umbilicus open, columella curved and bordered by a pink red stripe that can be very faint in some specimens. Color yellowish (or white) with black apex and bars.

Etymology. This new species is named in honor of Huynh Anh from Vietnam for supplying the type material.

Discussion. The new species is close to *Amphidromus kaloensis* Fulton, 1896 (Figure 23) but differs mainly in not swollen body whorl, less constricted sutures, straight-sided and more tapering spire, black (not brown) bars at outer surface. *Amphidromus inconstans* Fulton, 1898 (Figures 21, 22) resembles the new species in intermittent spiral bands but differs mainly in broader shape, much yellower background color and body whorl much wider than penultimate whorl. *Amphidromus bernardfamyi* Thach, 2017 (Figure 24) is distinguished mainly from the new species in squarish (not elongate) bars, larger band surrounding columella, widely-open umbilicus and translucent white (not porcelainous white) columella.

ACKNOWLEDGEMENTS

I express thanks to the Natural History Museum of London, UK for the photo of *Amphidromus kaloensis,* and to the anonymous reviewers for useful comments.

REFERENCES

Abbott, R.T. 1989. Compendium of landshells. American Malacologists Inc., Florida, USA, 240 pp.

Dharma, B. 2005. Recent & Fossil Shells of Indonesia. ConchBooks, Hackenheim, Germany, 432 pp.

Inkhavilay, K., C. Sutcharit & S. Panha. 2017. Taxonomic review of the tree snail genus *Amphidromus* Albers, 1850 (Pulmonata: Camaenidae) in Laos, with the description of two new species. European Jour. Taxonomy No 330. 1-40 (EJT-330). https://doi.org/10.5852/ejt.2017.330

Lok, A.F.S.L. & S.K.Tan, 2018. A review of the Singapore status of the green tree snail, *Amphidromus atricallosus perakensis* Fulton, 1901 and its biology. Nature in Singapore 1:225–230.

Parkinson, B., J. Hemmen & K. Groh. 1987. Tropical land shells of the world. Verlag Christa Hemmen, Wiesbaden, Germany, 279 pp.

Parsons, J. 2014. Lectotype designation and descriptions of two new subspecies of *Amphydromus* (*Syndromus*) *laevus* Mùller, 1774. Biodiversity Journal 5(2):175-196.

Raheem, D.C., H. Taylor, J. Ablett, R.C. Preece, N.A. Aravid, F. Naggs. 2014. A Systematic Revision of the Land Snails of the Western Ghats of India. Supplement 4, Museum of Natural History, Bangkok, 294pp.

Schileyko, A.A. 2011. Check-list of land pulmonate mollucs of Vietnam (Gastropoda: olumella but Stylommatophora). Ruthenica, Russia, Vol.21, No 1, 68pp.

Stanisic, J., M. Shea, D. Potter & O. Griffiths. 2010. Australian Land Snails, Volume 1. Bioculture Press, Mauritius, 591pp.

Sutcharit, C., J. Ablett, P. Tongkerd, F. Naggs & S. Panha. 2015. Illustrated type catalogue of *Amphidromus* Albers, 1850 in Natural History Museum, London, and descriptions of two new species. Zookeys 492:49-105.

Tan, S.K., S.Y. Chan & S.Panha. 2011. A New subspecies of *Amphidromus* (*Amphidromus*) *atricallosus* from Singapore (Mollusca: Gastropoda: Camaenidae). The Raffles Bull. Zoology (1):39-46.

Thach, N.N. 2005. Shells of Vietnam. ConchBooks, Hackenheim, Germany, 430 pp. (including 92 color plates).

Thach, N.N. 2007. Recently collected Shells of Vietnam. L'Informatore Piceno & NNT, Ancona, Italy, 380 pp. (including 118 color plates).

Thach, N.N. 2012. New Records of Molluscs from Vietnam. 48HrBooks Co., USA, 427 pp. (including 151 color plates).

Thach, N.N. 2016. Vetnamese New Mollusks. 48HrBooks Co., USA, 205 pp. (including 99 color plates).

Thach, N.N. 2017. New Shells of Southeast Asia. 48HrBooks Co., USA, 128 pp. (including 61 color plates).

Thach, N.N. 2018. New Shells of South Asia. 48HrBooks Co., USA, 173 pp. (including 87 color plates).

Website of National Museum of Natural History, London, UK.

www.seashells.net

australian seashells

seashells · décor · starfish
specimen shells · seashell books

Simone Pfuetzner · Hugh Morrison
5 Ealing Mews
Kingsley WA 6026 - Australia
Ph: +61 8 9409 9807
shells@seashells.net.au

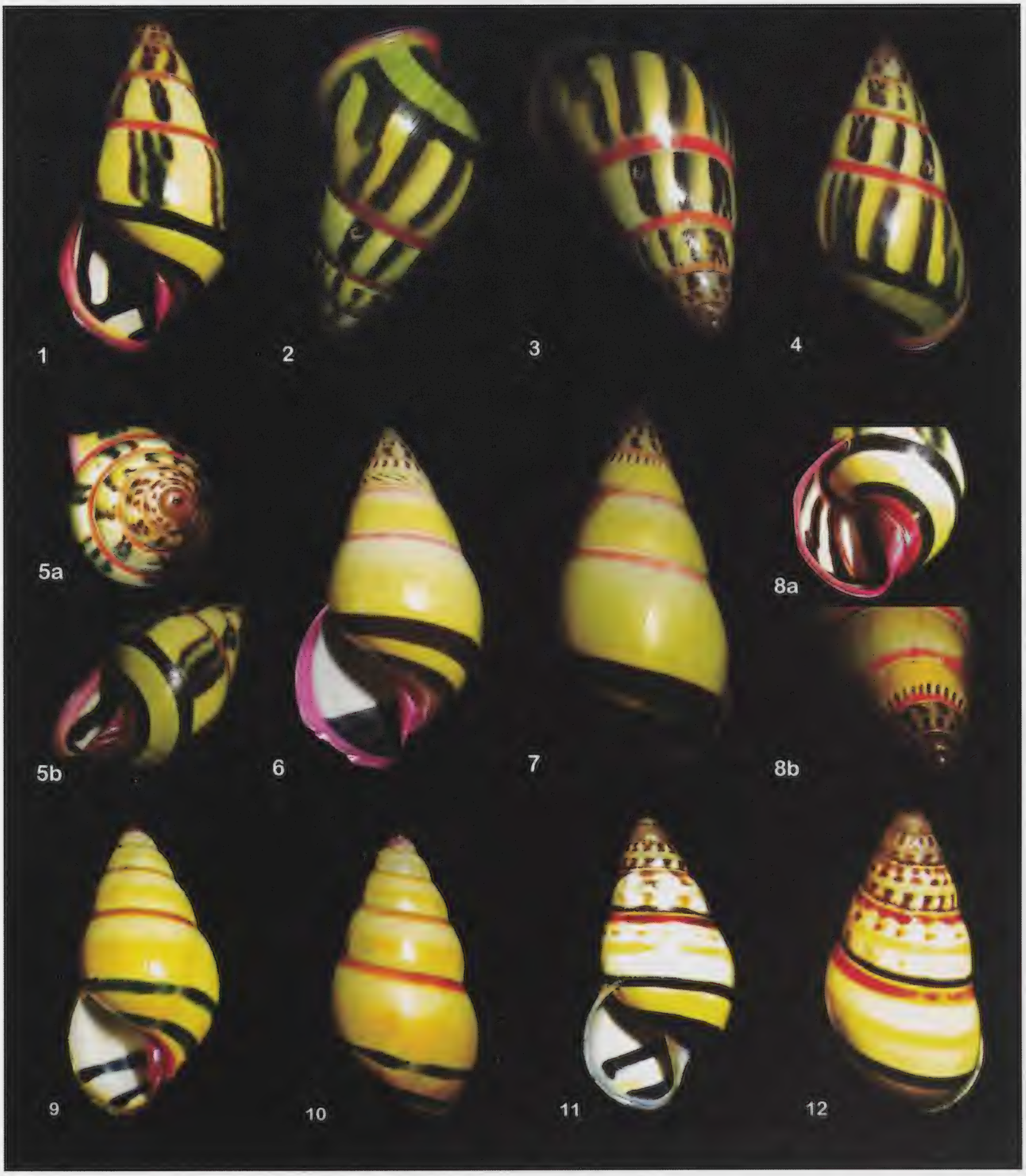


Plate 1. Figures 1-8: *Amphidromus philipeboucheti* Thach, 2019, Đắk Nông, Vietnam - **1**: Holotype 24.2 mm with ventral view in MNHN - **2**: Holotype with reflected outer lip - **3**: Holotype with spire view - **4**: Holotype with dorsal view - **5a**: Holotype with enlarged apex - **5b**: Holotype with enlarged umbilicus - **6**: Paratype 1, 27.5 mm with ventral view - **7**: Paratype 1 with dorsal view - **8a**: Interior view of aperture of holotype - **8b**: Spire view of paratype **1**- **9, 10**: *Amphidromus koenigi* Thach & Huber, 2018 for comparison - **11, 12**: *Amphidromus laii* Thach, 2019 for comparison.

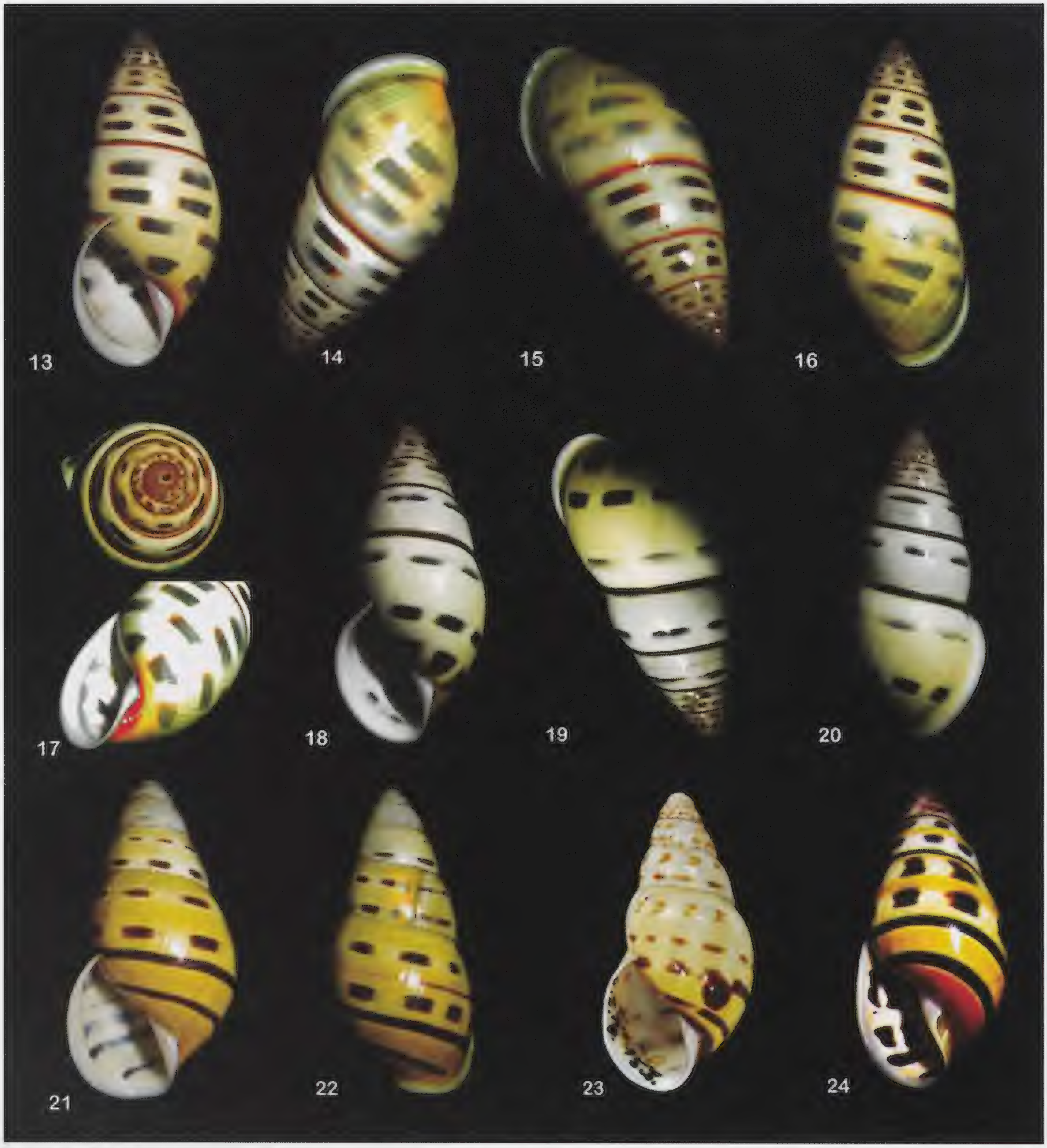


Plate 2. Figures. 13-20: *Amphidromus huynhi* Thach, 2019, Đắk Lắk, Vietnam - **13**: Holotype 29.5 mm with ventral view in MNHN - **14**: Holotype with reflected outer lip - **15**: Holotype with spire view - **16**: Holotype with dorsal view - **17**: Holotype with enlarged apex (top) and umbilicus (bottom) - **18**: Paratype 1, 31.2 mm with ventral view - **19**: Paratype 1 with spire view - **20**: Paratype 1 with dorsal view - **21,22**: *Amphidromus inconstans* Fulton, 1898 for comparison - **23:** *Amphidromus kaloensis* Fulton, 1896 for comparison, photo of NHMUK - **24**: *Amphidromus bernardfamyi* Thach, 2017 for comparison.

Volume: 51 THE FESTIVUS ISSUE 2

New records of nudibranchs (Gastropoda: Heterobranchia) from the coast of Pakistan (Northern Arabian Sea)

Shahnawaz Gul
Jamia Millia Government Degree College, Malir, Karachi, Pakistan
gulshahnawaz@yahoo.com

ABSTRACT This study reports fifteen species of nudibranchs from the coast of Pakistan (Northern Arabian Sea) except *Jorunna funebris* reported here, all are new records.

KEY WORDS Heterobranchia, Cladobranchia, Doridina, Karachi, new records

INTRODUCTION

Nudibranchs or sea slugs are colorful, shell-less, marine heterobranch gastropods in the order Nudibranchia comprising more than 2000 species worldwide (Gosliner *et al.*, 2008). Due to loss of adult shell, they have evolved various anti-predator strategies, like chemical defense, use of nematocysts obtained from cnidarian prey, warning or aposematic coloration, camouflage and mimicry (Gosliner, 2001; Wägele & Klussmann-Kolb, 2005; Greenwood, 2009; Aguado & Marin, 2007; Haber *et al.*, 2010; Putz *et al.*, 2010). Because of the presence of biochemically active compounds, dietary or biosynthetic, nudibranchs have gained increasing interest in natural products research (Avila, 1995; Dean & Prinsep, 2017).

Little is known about the nudibranch fauna of Pakistan (Northern Arabian Sea). The current knowledge on the subject comes from a checklist of opisthobranchs of Karachi which documents twenty-two species (Kazmi *et al.*, 1996) and a report on new record of *Dendrodoris krusensternii* published later on (Khanam & Kazmi, 2016). The information compiled in these papers, however, mentions almost nothing about the earlier studies on nudibranchs in Pakistan, except for a single contribution made by Eliot (1905), who provided some notes on nudibranchs of Karachi coast.

The present work is based upon opportunistic data on underwater photography of marine life recorded voluntarily by the Pakistani recreational SCUBA divers during diving/snorkeling excursions along Charna Island (24° 53′ 56.422″ N, 66° 36′ 15.297″ E) located off the Mubarak village, Karachi, and presently the most popular place for such activities. These SCUBA diving organizations post the photographs on their websites. Nudibranchs were photographed mostly, from 2015 to 2018 at average depth of 10 meter along Charna Island. Species recorded were identified by the author using W.B. Rudman's Sea Slug Forum (seaslugforum.net/), Pola *et al.* (2005), Camacho-García & Gosliner (2008) and Yonow (1988, 1989, 1996, 2001a and b, 2012, 2018).

A total of fifteen species were identified and reported here of which except *Jorunna funebris* are all new records. Each species is presented here with salient diagnostic features, its general geographic distribution and recent records of occurrence in the Arabian Sea, where available in literature. In addition, brief remarks have been given on each of the species to point out any morphological peculiarity in relation to identification and comparison with congener. The classification of nudibranchs used herein is adapted from Bouchet *et al.* (2017) whereas, taxonomic authorities of order Nudibranchia and its suborders appear unsettled in the current literature and is thus not mentioned. This study represents an entirely a citizen science initiative.

SPECIES ACCOUNTS

Order Nudibranchia
Suborder Doridina
Family Chromodorididae Bergh, 1891

Goniobranchus annulatus (Eliot, 1904)
(Figure 1A)

Description. Body white with bright yellow raised spots on mantle. Two dark purple-black rings, each around rhinophores and gills; rings completely separated. Rhinophores, gills and mantle margin also tinged with purple-black.

Remarks. The rings, however, may be joined by a median line. Occurrence of both these forms has recently been reported from Arabian Gulf (see Nithyanandan, 2012).

Distribution. Red Sea and Western Indian Ocean. Arabian Sea: Oman (Yonow, 2012), Kerala, India (Chandran *et al.*, 2017) and Pakistan.

Goniobranchus cavae (Eliot, 1904)
(Figure 1B)

Description. Body white with scattered small, round black spots and numerous yellow spots of different sizes; black spots surrounded by white lines. Border of mantle white/free of spots and edged with faint violet shade. Gills and rhinophores tinged violet.

Remarks. Yonow (2012) pointed out variations in morphology of this species including lack of violet margin on both mantle and foot.

Distribution. Western Indian Ocean. Arabian Sea: Kerala, India (Chandran *et al.*, 2017) and Pakistan.

Goniobranchus decorus (Pease, 1860)
(Figure 1C)

Description. Body translucent grey-white bearing orange border with single row of irregular shape purple spots on inner side and a thin opaque white line running longitudinally parallel to mantle margin encircling rhinophores and gills. Dorsum has similar white line medially which bifurcates in Y-shape around gills and without any spots.

Remarks. Above morphology with median line unspotted indicates *Goniobranchus setoensis* (Baba, 1938), however, Yonow (2012, plate 41, 42) identified her specimens with similar character as *G. decorus* which supports Rudman's (2007a) view that the mentioned species is a variant of *G. decorus*, is adapted here.

Distribution. Indo-west Pacific. Arabian Sea: Oman (Yonow, 2012), Lakshadweep (Apte, 2009, as *Chromodoris* cf. *setoensis*) and Pakistan.

Goniobranchus tumuliferus (Collingwood, 1881)
(Figures 1D, E)

Description. Body white bearing brown-red spots, no or variably tint with blue, and bright yellow submarginal border on mantle and foot. Mantle below border having blue spots or mixed with red ones and interrupting border. Rhinophores and gills tinged with yellow (Rudman, 1999a).

Remarks. *Goniobranchus kitae* described from the Northern Madagascar (Gosliner, 1994) shows close resemblance to the given species and differs mainly in having tiny opaque white spots on the rhinophores and gills (Rudman, 2002a, 2002b).

Distribution. Central Indo-Pacific (Mehrotra & Scott, 2015; Sachidhanandam, 2000). For further records, see Rudman's Sea Slug Forum. This is possibly, first record of *G. tumuliferus* from the Western Indian Ocean.

Glossodoris pallida (Rüppell & Leuckart, 1830)
(Figure. 1F)

Description. Body white with opaque white raised markings in the mid dorsal line. Two marks prominent; one like large spot behind rhinophores and other, inverted V-shaped mark. Mantle margin folded, edged with faint yellow. Rhinophores and gills white; tips tinged with yellow.

Distribution. Red Sea and Indo-west Pacific. Arabian Sea: Oman (Yonow, 2012) and Pakistan.

Glossodoris rufomarginata (Bergh, 1890)
(Figure 1G)

Description. Mantle bearing tan-brown colored speckled pattern on dorsum, submarginal white border and brown margin. Rhinophores and gills brown with white edges.

Distribution. Red Sea and Indo-west Pacific. Arabian Sea: Kerala, India (Chandran *et al.*, 2017) and Pakistan.

Hypselodoris ghardaqana
(Gohar & Aboul-Ela, 1957)
(Figure 1H)

Description. Body opaque white bearing bright yellow spots of different sizes on dorsal surface of mantle and foot. Mantle margin and posterior edge of foot deep blue. Rhinophore clubs maroon. Gills white with maroon edges (see Rudman, 2007b).

Distribution. Red Sea and Indian Ocean. Arabian Sea: Oman (Rudman, 2000) and Pakistan.

Hypselodoris infucata
(Rüppell & Leuckart, 1830)
(Figure 2A)

Description. Body grey-white bearing small, round spots of yellow and blue-black colour, and one row of blue-black patches on either side of dorsum. Mantle margin bordered with yellow and blue-black spots. Rhinophore clubs and gill edges light orange.

Remarks. The individual showing resemblance with *Hypselodoris sagamiensis* (Baba, 1949) but this species has pustules on dorsum and yellow spots only on the mantle margin. One record with similar morphology has been mentioned at sea slug forum (see Deomurari, 2007).

Distribution. Mediterranean, Red Sea and Tropical Indo-Pacific. Arabian Sea: Lakshadweep, India (Apte, 2009) and Pakistan.

Family Discodorididae Bergh, 1891

Jorunna funebris (Kelaart, 1859)
(Figure 2B)

Description. Body covered with tiny tubercles, caryophyllidia, giving velvety appearance to mantle. Background color white bearing jet black, partially pigmented, rings of different sizes; larger rings in the middle of dorsum. Rhinophore clubs jet black. Gills white with jet black rachis. Border of mantle with spots and smaller rings of black color.

Distribution. Red Sea and Tropical Indo-west Pacific. Arabian Sea: Lakshadweep, India (Apte, 2009) and Pakistan.

Family Phyllidiidae Rafinesque, 1814

Phyllidia ocellata Cuvier, 1804
(Figure 2C)

Description. Mantle bearing yellow tubercles of different sizes; larger, mostly in mid-dorsum gradually smaller and abundant on margin. Jet-black color bordered in white expand and meander on both sides of mantle forming rings. Surface of tubercles irregular having tiny warts or tubercles. Sides of mantle with small, round black spots. Rhinophores yellow.

Distribution. Red Sea and Tropical Indo-west Pacific (Rudman, 1999b). Arabian Sea: Pakistan.

Phyllidia picta Pruvot-Fol, 1957
(Figure 2D)

Description. Mantle bearing three rows of orange-yellow capped tubercles on mid-dorsum, one medial and two outer; each outer row comprising at least two larger tubercles in middle (see Yonow, 2001b, 2012: fig. 16 A). Dorsum covered with black color which form transverse rays giving blue-grey scalloped pattern on sides having tubercles. Rhinophores orange-yellow.

Distribution. Indo-west Pacific (Rudman, 2006a; Yonow, 1996, 2012). Arabian Sea: Pakistan. Yonow (2012) documented the species from Socotra which is perhaps the only record from the Western Indian Ocean, so far.

Phyllidia rueppelii (Bergh, 1869)
(Figure 2E, F)

Description. Mantle having three less organized rows of orange-yellow capped tubercles on mid dorsum; one medial and two outer rows, and yellow margin. Ground color blue-grey with black on dorsum; black rays on sides forming blue-grey scalloped pattern provided with tubercles.

Remarks. In *P. rueppelii*, dorsal tubercles among three rows sometimes appear cross connected by blue-grey ground color (see Nithyanandan, 2012: fig. 6). In addition, yellow mantle margin is the most recognizable character of this species.

Distribution. Red Sea, Northwestern Indian Ocean, and Western Australia (Rudman, 2006b). Arabian Sea: Oman (Rudman, 2008) and Pakistan.

Family Polyceridae Alder & Hancock, 1845

Tyrannodoris luteolineata (Baba, 1936)
(Figure 2G)

Description. Body elongate having long, pointed posterior end of foot. Ground color black with four green-yellow lines/stripes on dorsum; two medial passing from mid of rhinophores to base of gills and two outer, each arising from rhinophores. Head bearing two green-yellow markings between rhinophores and connected with medial lines. Rhinophores black. Gills black with green-yellow rachis (see Rudman, 2001; Pola *et al.* 2005: fig. 6).

Remarks. This species may be confused with *Tambja affinis* known from the Western Indian Ocean which, however, has one milky-green mark between the rhinophores (Yonow, 1990; Rudman, 2005).

Distribution. Central Indo-Pacific and South Africa (see Pola *et al.* 2005). This is possibly, first record of *T. luteolineata* from the Western Indian Ocean.

Suborder Cladobranchia
Family Flabellinidae Bergh, 1889

Coryphellina rubrolineata O'Donoghue, 1929
(Figure 2H)

Description. Body elongate, pale translucent with some white pigments and three magenta lines longitudinally, one medial and two outer. Cerata long, pointed and tinged with magenta near ends and white tips.

Distribution. Red Sea, and Tropical and subtropical Indo-Pacific (Rudman, 1998; Yonow, 2000). Arabian Sea: Pakistan.

Family Tethydidae Rafinesque, 1815

Melibe japonica Eliot, 1913
(Figure 3)

Description. Body elongate, translucent pink with proportionally large oral hood and broad, flat cerata. Body covered with scattered tiny, white-speckled tubercles of different sizes. Dorsum and cerata bearing brown spots/blotches and rose-pink round tubercles, and a row of yellow-speckled tubercles on distal margin of cerata. Oral hood also bearing transparent, pointed papillae/tubercles on outer surface.

Distribution and Remarks. This species is known from Western Pacific: Japan, Korea and Eastern Australia (Rudman, 2004), and currently exists as uncertain synonym of *M. viridis* based upon Gosliner & Smith (2003, pg. 324; MolluscaBase, 2018). A detail morphological and anatomical study of *M. japonica*, which is lacking in the scientific literature, and comparison of molecular analysis of the two species can resolve its taxonomic status. This is first record of the genus *Melibe* from Pakistan.

ACKNOWLEDGMENTS

The author thanks the Pakistani SCUBA diving organizations: Divers Reef Karachi https://www.facebook.com/DiversReefKarachi/, Indus Scuba https://www.facebook.com/ IndusScuba/, Karachi Scuba Diving Center https://www.facebook.com/karachiscuba/, Pakistan Underwater Explorers https://www.facebook.com/PakistanUnderwaterExplorers/ all of which are highly acknowledged for the underwater photography of sea slugs.

REFERENCES

Aguado, F. and A. Marin. 2007. Warning coloration associated with nematocyst-based defenses in aeolidiodean nudibranchs. Journal of Molluscan Studies 73(1):23-28.

Apte, D. 2009. Opisthobranch fauna of Lakshadweep Islands, India, with 52 new records to Lakshadweep and 40 new records to India: part 1. Journal of the Bombay Natural History Society 106(2):162-175.

Avila, C. 1995. Natural products of opisthobranch molluscs: A biological review. Oceanography and Marine Biology: An Annual Review 33:487-559.

Bouchet, P., J.-P. Rocroi, B. Hausdorf, A. Kaim, Y. Kano, A. Nützel, P. Parkhaev, M. Schrödl, E.E. Strong. 2017. Revised classification, nomenclature and typification of gastropod and monoplacophoran families. Malacologia 61(1-2):1-526.

Camacho-García and T. M. Gosliner. 2008. Systematic revision of *Jorunna* Bergh, 1876 (Nudibranchia, Discodorididae) with a morphological phylogenetic analysis. Journal of Molluscan Studies 74:143-181.

Chandran, B.K.S., S. Shrinivaasu, R. Ravinesh, P. Robert, A.B. Aneesha and A.B. Kumar. 2017. Opisthobranch (Mollusca, Gastropoda) fauna of Kerala, India: a citizen science initiative. Journal of the Marine Biological Association of India 59(1):49-58.

Dean, L.J. and M.R. Prinsep. 2017. The chemistry and chemical ecology of nudibranchs. Natural Product Reports 34:1359-1390.

Deomurari, A. 2007. *Hypselodoris infucata* from the Gulf of Kutch, India. Message dated February 9 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/19388.

Eliot, C.N.E. 1905. Nudibranchs from the Indo-Pacific. I. Notes on a collection dredged near Karachi and Maskat. Journal of Conchology 11(8):237-256.

Gosliner, T.M. 1994. New species of *Chromodoris* and *Noumea* (Nudibranchia, Chromodorididae) from the western Indian Ocean and southern Africa. Proceedings of the California Academy of Sciences 48(12):239-252.

Gosliner, T.M. 2001. Aposematic coloration and mimicry in opisthobranch molluscs: new phylogenetic and experimental data. Bollettino Malacologica 37:163-170.

Gosliner, T.M. and V.G. Smith. 2003. Systematic review and phylogenetic analysis of the nudibranch genus *Melibe* (Opisthobranchia, Dendronotacea) with descriptions of three new species. Proceedings of the California Academy of Sciences 54(18):302-355.

Gosliner, T.M., D.W. Behrens and A. Valdes. 2008. Indo-Pacific nudibranchs and sea slugs: A field guide to the world's most diverse fauna. Sea Challengers Natural History Books and California Academy of Sciences. 426 pp.

Greenwood, P. G. 2009. Acquisition and use of nematocysts by cnidarian predators. Toxicon 54:1065-1070.

Haber, M., S., Cerfeda, M. Carbone, G. Calado, H. Gaspar, R. Neves, V. Maharajan, G. Cimino, M. Gavagnin, M.T. Ghiselin and E. Mollo. 2010. Coloration and defense in the nudibranch gastropod *Hypselodoris fontandraui*. Marine Biological Laboratory 218(2):181-188.

Kazmi, Q.B., N.M. Tirmizi and I. Zehra. 1996. A checklist of opisthobranch snails of the Karachi coast. Pakistan Journal of Marine Sciences 5(1):69-104.

Khanam, S. and Q.B. Kazmi. 2016. A new record of *Dendrodoris krusensternii* (Gray, 1850) (Nudibranchia, Dendrodorididae) from the Karachi coast, Pakistan (Northern Arabian Sea). International Journal of Fauna and Biological Studies 3(4):76-77.

Mehrotra, R. and C.M. Scott. 2015. Species inventory of sea slugs (Gastropoda: Heterobranchia) for Koh Tao, Thailand, with 25 first records for Thai waters. Marine Biodiversity 46:761-771.

MolluscaBase. 2018. *Melibe viridis* (Kelaart, 1858). Accessed through: World Register of Marine Species at: http://www.marinespecies.org/aphia.php?p=taxdetails&id=181237 on 2018-09-04.

Nithyanandan, M. 2012. New and rare nudibranch records from Kuwait, Arabian Gulf (Mollusca, Opisthobranchia). Marine Biodiversity Records 5:1-7.

Pola, M., J.L. Cervera and T.M. Gosliner. 2005. Review of the systematics of the genus *Roboastra* Bergh, 1877 (Nudibranchia, Polyceridae, Nembrothinae) with the description of a new species from the Galapagos Islands. Zoological Journal of the Linnean Society 144:167-189.

Putz, A., G.M. König and H. Wägele. 2010. Defensive strategies of Cladobranchia (Gastropoda, Opisthobranchia). Natural Product Report 27:1386-1402.

Rudman, W.B. 1998. *Flabellina rubrolineata* (O'Donoghue, 1929). Message dated January 9 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/flabrub.

Rudman, W.B. 1999a. *Chromodoris tumulifera* Collingwood, 1881. Message dated May 21 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/chrotumu.

Rudman, W.B. 1999b. *Phyllidia ocellata* Cuvier, 1804. Message dated January 12 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/factsheet/phylocel.

Rudman, W.B. 2000. Comment on *Risbecia ghardaqana* from Oman by Gordon T. Smith. Message dated October 30 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/3256.

Rudman, W.B. 2001. Comment on *Roboastra luteolineata* from the Solomons by Scott Johnson. Message dated September 30 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/5326.

Rudman, W.B. 2002a. Comment on on *Chromodoris kitae* from Madagascar by Terry Gosliner. Message dated February 15 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/6243

Rudman, W.B. 2002b. *Chromodoris tumulifera* from New Caledonia. Message dated February 15 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/6244.

Rudman, W.B. 2003. Comment on *Hypselodoris infucata* or H. kanga? by Danny Van Belle. Message dated February 12 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/9133

Rudman, W.B. 2004. *Melibe japonica* Eliot, 1913. Message dated January 28 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/melijapo

Rudman, W.B. 2005. *Tambja affinis* (Eliot, 1904). Message dated August 15 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/tambaffi.

Rudman, W.B. 2006a. *Fryeria picta* (Pruvot-Fol, 1957). Message dated July 14 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/fryepict.

Rudman, W.B. 2006b. Comment on *Fryeria rueppelii* from Western Australia by Kristin. Message dated February 9 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.

net/find/15700.

Rudman, W.B. 2007a. Identity of *Chromodoris decora*. Message dated September 14 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/20717

Rudman, W.B. 2007b. Comment on *Risbecia ghardaqana* from Hurghada, Egypt by Greg Brown. Message dated October 16 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/20912.

Rudman, W.B. 2007c. Comment on *Hypselodoris kanga* laying eggs in Lembeh by Mike Krampf. Message dated July 28 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/20163.

Rudman, W.B. 2008. Comment on *Fryeria rueppelii* from the Gulf of Oman by Yahia Mokhtar. Message dated February 15 in Sea Slug Forum. Australian Museum, Sydney. Available from http://www.seaslugforum.net/find/21262.

Sachidhanandam, U., R.C. Willan and L.M. Chou. 2000. Checklist of the nudibranchs (Opisthobranchia, Nudibranchia) of the South China Sea. The Raffles Bulletin of Zoology, supplement 8:513-537.

Wägele, H. and A. Klussmann-Kolb. 2005. Opisthobranchia (Mollusca, Gastropoda) - more than just slimy slugs. Shell reduction and its implications on defence and foraging. Frontiers in Zoology 2:1-18.

Yonow, N. 1988. Red Sea Opisthobranchia 1: The family Phyllidiidae (Mollusca, Nudibranchia). Fauna of Saudi Arabia 9:138-151.

Yonow, N. 1989. Red Sea Opisthobranchia 2: The family Chromodorididae (Mollusca, Nudibranchia). Fauna of Saudi Arabia 10:290-309.

Yonow, N. 1990. Red Sea Opisthobranchia 3: The orders Sacoglossa, Cephalaspidea, and Nudibranchia: Doridacea (Mollusca, Opisthobranchia). Fauna of Saudi Arabia 11:286-299.

Yonow, N. 1996. Systematic revision of the family Phyllidiidae in the Indian Ocean province: part 1 (Opisthobranchia, Nudibranchia, Doridoidea). Journal of Conchology 35(6):483-516.

Yonow, N. 2000. Red Sea Opisthobranchia 4: The orders Cephalaspidea, Anaspidea, Notaspidea and Nudibranchia: Dendronotacea and Aeolidacea. Fauna of Arabia 18:87-131.

Yonow, N. 2001a. Results of the Rumphius Biohistorical Expedition to Ambon (1990). Part 11. Doridacea of the families Chromodorididae and Hexabranchidae (Mollusca, Gastropoda, Opisthobranchia, Nudibranchia), including additional Molukkan material. Zoologische Mededelingen, Leiden, 75(1-15):1-50.

Yonow, N. 2001b. Results of the Rumphius Biohistorical Expedition to Ambon (1990). Part 15. The suborder Doridina (Mollusca, Gastropoda, Opisthobranchia, Nudibranchia). Zoologische Mededelingen, Leiden 85:905-956.

Yonow, N. 2012. Opisthobranchs from the western Indian Ocean, with descriptions of two new species and ten new records (Mollusca, Gastropoda). Zookeys 197:1-129.

Yonow, N. 2018. Red Sea Opisthobranchia 5: new species and new records of chromodorids from the Red Sea (Heterobranchia, Nudibranchia, Gastropoda). Zookeys 770:9-42.

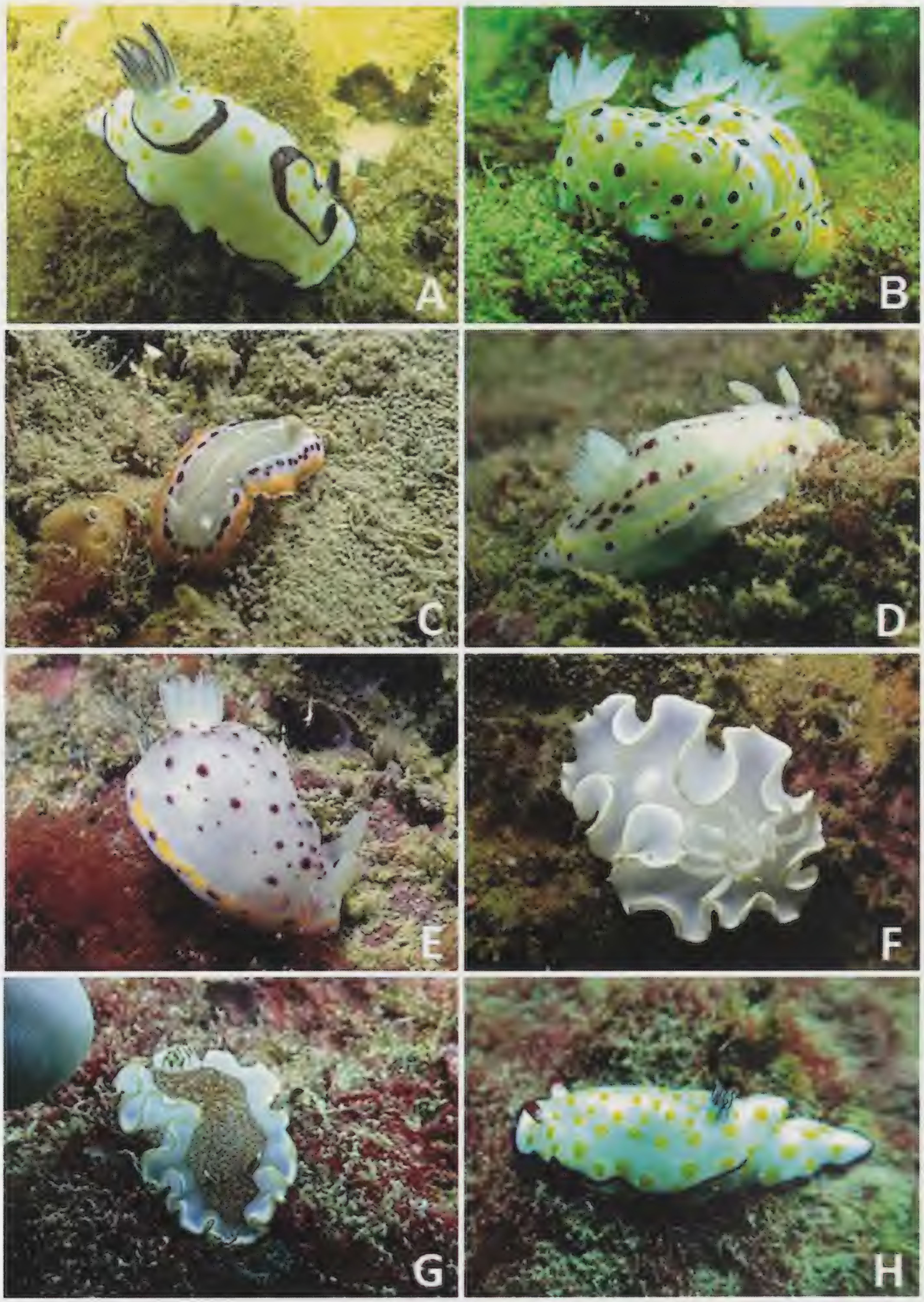


Figure 1. **A)** *Goniobranchus annulatus*; **B)** *Goniobranchus cavae*; **C)** *Goniobranchus decorus*; **D, E)** *Goniobranchus tumuliferus*; **F)** *Glossodoris pallida*; **G)** *Glossodoris rufomarginata*; **H)** *Hypselodoris ghardaqana*. Photos: A, Karachi Scuba Diving Center; B, Scuba Adventures Pakistan; C, D, E, F, G, Indus Scuba; H, Pakistan Underwater Explorers.

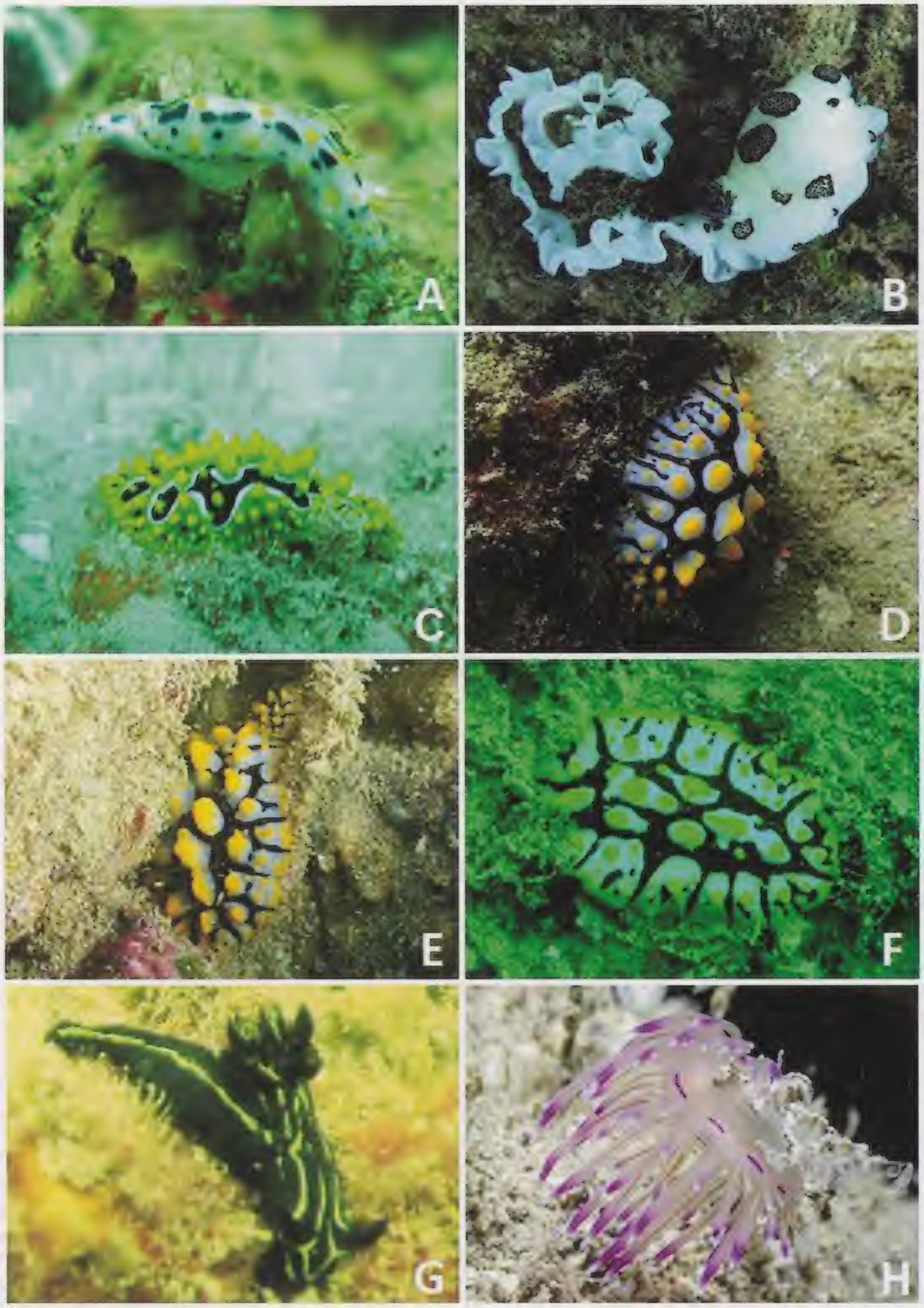


Figure 2. A) *Hypselodoris infucata* **B)** *Jorunna funebris*; **C)** *Phyllidia ocellata*; **D)** *Phyllidia picta*; **E, F)** *Phyllidia rueppelii*; **G)** *Tyrannodoris luteolineata*; **H)** *Coryphellina rubrolineata*. Photos: A, C Scuba Adventures Pakistan; B, D, E, H, Indus Scuba; F, G, Karachi Scuba Diving Centre.

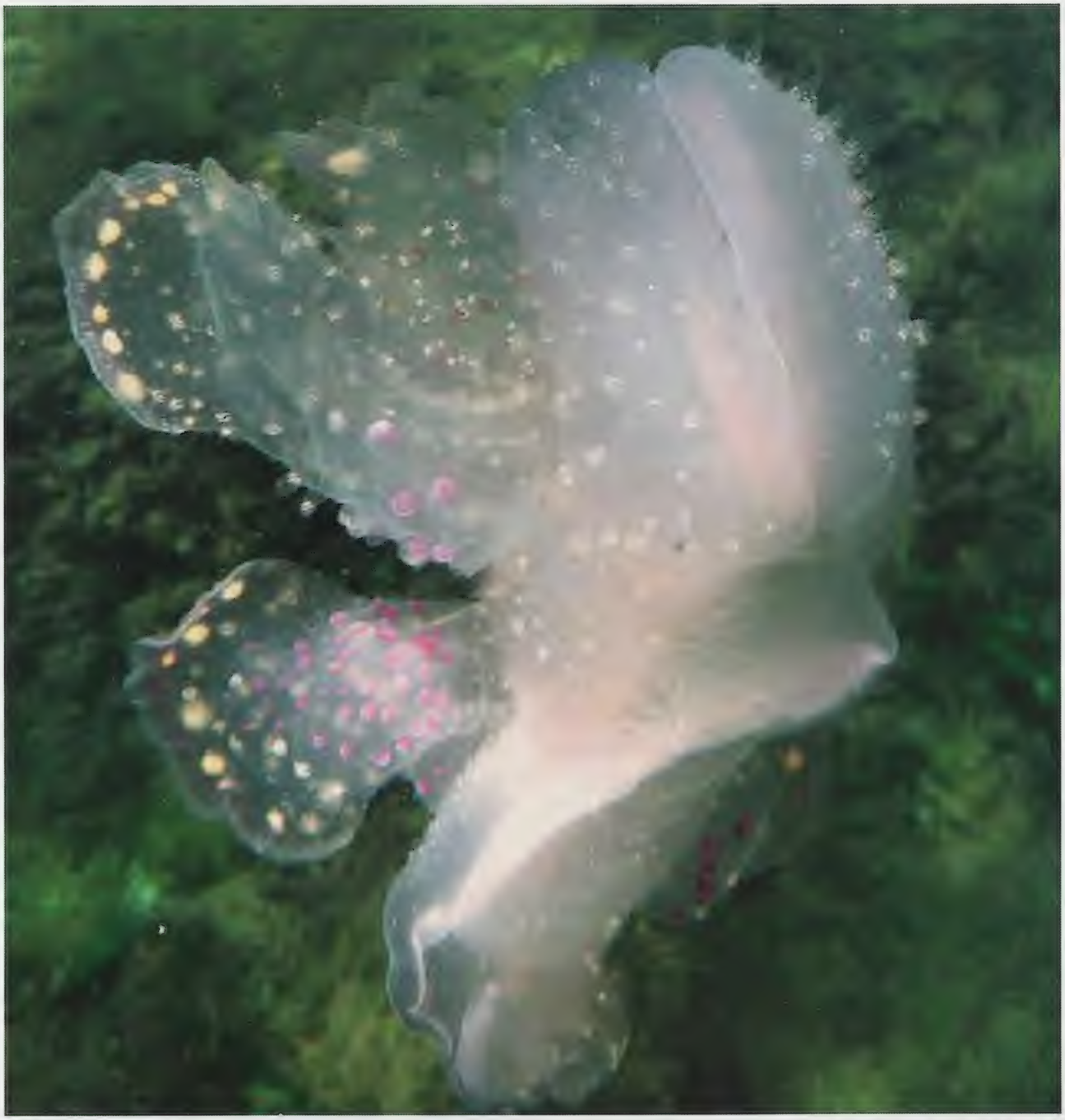


Figure 3. *Melibe japonica* specimen in close up. Photo: Divers Reef Karachi.

ISSN 0738-9388

Volume: 51 THE FESTIVUS ISSUE 2

The Fossil Cypraeidae of the Pinecrest Member (Unit 7) and Kissimmee River Valley Equivalent, Tamiami Formation of Southern Florida: (Mollusca: Gastropoda: Cypraeidae)

John D. "Duffy" Daughenbaugh
203 North Wilton Place, Los Angeles, CA. 90004
shoduffy@ca.rr.com

ABSTRACT Following the disappearance of the seven Buckingham Member (Unit 10) Cypraeidae from the Myakka Lagoon System (Myakka), there was a hiatus represented by two strata at Sarasota (Pinecrest Members 9 & 8) in the early Piacenzian Pliocene, 3.6 million years ago ("mya"), from which no Cypraeidae have been recorded. This was followed by the warmest and most tropical conditions of the entire Pliocene. The sea grass beds and mud flats, which were the preferred habitats of the Pinecrest Cypraeidae, returned in force. The depositional strata which resulted, Pinecrest (Unit 7) and its Kissimmee River Valley Equivalent, were very thick and probably represent a long period of uninterrupted deposition. Eight new species in six genera emerged in Myakka. In the Kissimmee River Valley (Kissimmee), six new species in three genera (one new) emerged as the first and earliest known Cypraeidae species from that area. This represented geographically separate, but parallel, evolutionary tracks. Pinecrest Members 6 & 5 represented a repeat of the conditions experienced during Pinecrest Members 9 & 8, resulting in the disappearance of all Pinecrest (Unit 7) Cypraeidae from Myakka and Kissimmee.

KEYWORDS Tamiami Formation, Buckingham Member, Pinecrest Member (Unit 7), Unit 7 equivalent, Cypraeidae, fossil, *Akleistostoma*, *Siphocypraea*, *Pahayokea*, *Calusacypraea*, *Pseudadusta*, Myakka Lagoon System, Sarasota area, Polk Peninsula, Kissimmee Embayment, Kissimmee River Valley, St. Lucie Peninsula, Caloosahatchee Strait, Loxahatchee Strait, Okeechobee Plains, Everglades Pseudoatoll

Peninsular Florida

During the Piacenzian Pliocene Epoch of about one million years (3.6-2.58 million years ago (hereinafter "mya")), which lasted until the end of the Pliocene, peninsular Florida was still not yet complete. In the west, the estuarine Myakka was isolated from the south by the Caloosahatchee Strait, which appears to have acted as an absolute barrier to the southward migration of Cypraeidae during the late Zanclean-early Piacenzian Pliocene (3.8-3.6 mya). However, during the Piacenzian, the strait apparently became more of an obstacle rather than a barrier with at least one species having been recorded in Lee and Collier County.

In the east, the Kissimmee Embayment and its southern sedimentary deposits formed a long and broad river valley (Kissimmee) and represented its southernmost extension. The Kissimmee encompassed the Kissimmee Embayment as well as the sedimentary deposits, which flowed into the embayment from the north and surrounds and southward into what today is the Okeechobee Plains. The plains, north of Lake Okeechobee, are low lying grasslands formed by a fairly continuous deposit of these sediments. Kissimmee habitats were thereby extended from Okeechobee County in the north, southward to encompass present day Osceola County, eastern Highland County, northeast Glades County and western Indian County where Pinecrest Member (Kissimmee Unit 7 equivalent) Cypraeidae are found. The Everglades Pseudoatoll lay to the south of Myakka and Kissimmee.

The pseudoatoll was bounded by coral reefs and coral reef tracts. In the east southeast, south of the Kissimmee, lay the Palm Beach Reef Tract with the Miami Reef Tract representing a continuation of the former, curving to the southwest along the southeast of the pseudoatoll. The pseudoatoll was bounded on the west by the Immokalee Reef Tract, a broad reef system, which ran south southeast from below Myakka. The Long Pine Key Reefs, a set of small reefs, ran from west to east between the southernmost tips of the Immokalee and Miami Reef Tracts. Experiencing periodic flooding and emergent events, the pseudoatoll grew in fits and starts and would remain separate from peninsular Florida until the Late Pleistocene when sediments would fill the remaining gaps.

The Piacenzian Pliocene of Southern Florida (Pinecrest Time)

Following a drop in sea levels, which occurred during the late Zanclean/early Piacenzian crossover period, southern Florida commenced a warming trend, which progressively produced the warmest and most tropical conditions of the entire Pliocene. This was manifested in rising sea levels, the expansion of sea grass bed habitats and mangrove forests and, in the Kissimmee, the formation of the mud and clay sedimentary strata, which would provide the habitat for Kissimmee equivalent Cypraeidae. The contemporaneous Golden Gate Member of the Everglades Pseudoatoll saw the commencement of the richest tropical hard coral fauna ever found in the Neogene western Atlantic.

Pinecrest and Contemporary Members, Tamiami Formation

In 1964, Olsson and Petit named the "Pinecrest Beds", as a molluscan biozone for the fauna contained in its sandy units, after the old Pinecrest settlement on the Everglades Road off U.S. Route 41 on the Dade-Collier County line. Pinecrest Index fossils were found throughout the Everglades region, including canal digs in Highlands and Glades Counties, *i.e.* Kissimmee. In 1968, Hunter provided the first lithographic description of the widespread shell beds and their fauna. This was further refined in Petuch's 1982 work. In 1992, Missimer gave a more detailed description of the areal extent of what he called the "Pinecrest Sand Beds". The name has been shortened to the Pinecrest Member and aligned with other southern Florida members.

Within the Piacenzian of southern Florida, there were three relevant Tamiami Formation members: the Pinecrest Member, the Golden Gate Member and the Fruitville Member. The Pinecrest is the oldest while the Golden Gate is roughly contemporaneous with both the Pinecrest and the younger Fruitville. The Pinecrest contemporaneous Ochopee Member of the southwestern Everglades area contains only Cypraeidae casts, leaving a void in our knowledge of the species in that member.

Similar to the Buckingham Member, the Pinecrest Member covered all of the Tamiami Formation of southern Florida. The focus of this paper is on Unit 7 of the Pinecrest Member along with its Kissimmee equivalent. It will discuss the two preceding units (9 and 8) as well as the ending units (6 and 5). It will also touch briefly on the Golden Gate Member.

Hiatus (Pinecrest Units 9 and 8)

Two thin (one meter thick each) depositional units overlay the quartz sand and mud of Unit 10 in the Myakka, suggesting short depositional periods. Unit 9 represented a dramatic change with oyster shell beds (*Hyotissa meridionalis* Heilprin, 1886) dominating. They formed in subtidal/surface areas in quiet lagoon areas and were so tightly packed that only small amounts of sand were present among these beds. Unit 8, overlaying Unit 9, also represented a further dramatic change with gastropod worm reefs (*Vermicularia recta* Olsson & Harbison, 1953) overlaying the oyster beds. The large size of the worms and their solid beds implies a significant high nutrient riverine input into the lagoon in support.

Such conditions imply that the climax of the late Zanclean Age cooling period extended into the earliest Piacenzian causing reduced sea levels. This would have reduced the sea grass beds and mud flats, which so dominated Unit 10, such that no Cypraeidae have been recorded in either the Unit 9 or 8 strata. That does not mean that there were no Cypraeidae populations extant during these periods. The presence of small, isolated populations may be inferred by the emergence of new species in Unit 7 of the Pinecrest. These would have existed outside the recent quarries and collection sites in those areas.

Pinecrest (Unit 7) Myakka Lagoon System

In the Myakka, habitats, which were virtually identical to those which existed in Buckingham (Unit 10), returned. Composed of quartz sand, often mixed with variable (gradational) amounts of lime muds, the five meters thick strata represent a long depositional period and is considered the main bed of the Pinecrest. Eight new species in five genera emerged.

The shallow water, low salinity mud flats associated with river mouths supported the emergence of two estuarine species in the neotenic *Calusacypraea* (Petuch, 2004) genus. Neoteny is defined as the retention in adults of certain juvenile features, either delayed or permanent, which represent an advantage to the species. With *Calusacypraea* species, it is a likely a permanent adaptation to the environment of its habitat. The genus is considered neotenic when all species within the genus are neotenic. Separately, *Akleistostoma patula* Petuch and Drolshagen, 2011 is associated with mud flats near mangrove forests. The small, intertidal sea grass beds served as perfect habitats for emergent weed eating Cypraeidae species.

However, the areal extent of the Pinecrest sea grass beds was not limited to the Myakka. To the south of Myakka lay the Everglades Pseudoatoll and its Golden Gate Member. The Golden Gate, contained within the pseudoatoll, was defined based on its coral reefs, coral reef tracts and coralline habitats. However, sand flats covered with sea grass also interfingered with the reefs and reef tracts providing substantially the same habitat as the sand and sea grass beds at Myakka. As evidence, *Akleistostoma floridana* (Mansfield, 1931), commonly found in Unit 7 of the Sarasota quarries, has been recorded in the quarries of Lee and Collier Counties to the south of Sarasota. While *A. floridana* existed in the Pinecrest, only specimens collected from the Sarasota area are designated Unit 7.

This suggests that the Caloosahatchee Strait was no longer an absolute barrier to southward migration of Cypraeidae species and it is possible, if not probable, that other species may have breached the strait.

Pinecrest (Unit 7) Kissimmee River Valley Equivalent

Buckingham Member Unit 10 was extant in the upper reaches of Kissimmee. However, in its lower reaches, sediments have been leached leaving only riverine rocks/stones intermixed with broken mollusk fragments. No Buckingham Cypraeidae have been recorded from Kissimmee. Units 9 & 8 are not present in the valley as the estuarine habitats of Myakka did not exist in Kissimmee. However, the presence of Cypraeidae extant during these periods is inferred as the emergence of six species in three genera in Unit 7 equivalent supports their prior existence.

In the Kissimmee, the sedimentary facies differ from other areas of the Pinecrest in general and Myakka in particular. The strata, formed in its estuaries, shallow banks and tidal channels, consists of mud, clay minerals, organic particulate matter mixed with sand and shell bioclasts in mud flats and mangrove tree forests. Hence, fossil Cypraeidae collected in the river valley have been designated equivalent members. Fossil Cypraeidae have been collected in what would have been sea grass beds, and mud flats in tidal channels near Black and Red Mangrove forests.

In addition to *Calusacypraea* (see above), a neotenic genus also emerged in the Kissimmee, *i.e. Okeechobea* (Petuch, 2004). The more delicate, bubble like species preferred muddy estuarine and mangrove habitats which were exposed at low tide and represent a likely adaptation to their environment. Two species of *Okeechobea* emerged in Unit 7 equivalent. The other Kissimmee Cypraeidae are associated with sea grass beds and mud flat habitats.
The Kissimmee Unit 7 equivalent facies remained constant throughout the Pinecrest. As a result, the well defined Pinecrest units (strata) of Sarasota do not exist. Rather the strata represent a continuum throughout the Pinecrest, *i.e.* only Unit 7 equivalent existed in Kissimmee during Pinecrest time. The equivalent unit is inferred based upon Index shell fossils from other known, well defined fossil sites.

Hiatus (Pinecrest Units 6 and 5)

The end of Pinecrest time was marked by Units 6 and 5, representing the return of the Unit 9 and 8 conditions at Sarasota. The strata were of similar thickness, one meter each, and were dominated by the same oyster beds and gastropod worm reefs. During this period, all Unit 7 and equivalent Cypraeidae species disappeared. New species would only emerge during the subsequent Fruitville Member.

Pinecrest Member Species

Myakka Lagoon System (Sarasota) Unit 7
Akleistostoma floridana (Mansfield, 1931) - Figure 2A
Akleistostoma patula Petuch and Drolshagen, 2011 - Figure 2B
Akleistostoma (Mansfieldicypraea) rugostoma Petuch and Drolshagen, 2011 - Figure 2C
Siphocypraea (Seminolecypraea) trippeana Parodiz, 1988 - Figure 2D
Pahayokea (Gardnericypraea) mansfieldi (Petuch, 1998) - Figure 2E
Calusacypraea globulina Petuch, 2004 - Figure 2F
Calusacypraea (Myakkacypraea) briani (Petuch 1996) - Figure 2G
Pseudadusta hertweckorum (Petuch, 1991) - Figure 2H

Kissimmee River Valley restricted (Unit 7 equivalent)
Akleistostoma (Ingramicypraea) highlandensis Petuch and Drolshagen, 2011 - Figure 1A
Akleistostoma (Olssonicypraea) hughesi (Olsson and Petit, 1964) - Figure 1B

Pahayokea kissimmeensis (Petuch, 1994) - Figure 1C
Pahayokea (Kissimmecypraea) transitoria (Olsson and Petit, 1964) - Figure 1D
Okeechobea osceolai Petuch and Drolshagen, 2011 - Figure 1E
Okeechobea (Yeehawcypraea) bartoni Petuch and Drolshagen, 2011 - Figure 1F

Altogether, 14 species in six genera have been collected in Pinecrest Unit 7 deposits and its equivalent.

For detailed genera and species descriptions, background information and discussion, see Jewels of the Everglades, The Fossil Cowries of Southern Florida, 2018, by Edward J. Petuch, David P. Berschauer and Robert F. Myers.

Origins - Myakka

Two Myakka *Akleistostoma* species appear to be offshoots of *Akleistostoma carolinensis* (Conrad, 1841), with *A. floridana* inhabiting sea grass beds while *A. patula* represented an adaptation to mud flat environments. *Akleistostoma rugostoma* represents a larger and more inflated version of *Akleistostoma crocodila* (Petuch, 1994). The more well developed extremities of *S. (S.) trippeana* separate it from *Siphocypraea (Seminolecypraea) micanopy* Petuch and Drolshagen, 2011 and presage the coiled apical sulcus of later *Siphocypraea* Heilprin, 1886. *Pahayokea (G.) mansfieldi* most closely resembles its predecessor, *Pahayokea (Gardnericypraea) erici* (Petuch, 1998). A steinkern cast of *Calusacypraea polkensis* Petuch and Drolshagen, 2011 of the late Miocene was collected in a quarry north of Sarasota in what would have been the western fringes of the Polk Peninsula. It is similar to *C. globulina* and is its probable predecessor. *Calusacypraea (M.) briani* is a more slender and less inflated version of the older *Calusacypraea duerri* (Petuch, 1996). *Pseudadusta hertweckorum* is a more oval version of the older *Pseudadusta buckinghamensis* Petuch and Drolshagen, 2011.

Origins - Kissimmee

The origins of the Kissimmee species are more speculative due to the absence of known fossil shell beds below the Pinecrest beds and the limited number of collecting sites over a very large area. In addition, the Polk Peninsula, as well as the Caloosahatchee and Loxahatchee Straits acted as an intervening barrier between Myakka and Kissimmee, resulting in a large degree of genetic separation. Nevertheless, possible, if not probable, connections can be posited.

Given its wide range, *Akleistostoma (Ingramicypraea) pilsbryi* (Ingram, 1939) was probably extant in the Kissimmee prior to the Pinecrest. It most closely resembles *A. (I.) highlandensis* and is its probable predecessor. Likewise, *A. (O.) hughesi* resembles a large, depressed *A. pilsbryi* and is probably a highly localized evolutionary offshoot restricted to the sea grass beds, mangrove forest and mud flats. The two *Pahayokea* species (*P. kissimmeensis and P. (K.) transitoria*) are evolutionary offshoots of an unknown species.

Okeechobea represents an entirely new genus. Like the *Calusacypraea*, they retain certain juvenile features into adulthood. While the coiled apical sulcus present to a greater or lesser extent in all its species would suggest a *Siphocypraea* Heilprin, 1886 offshoot, there does not appear to be a predecessor in that genera, which would serve as rootstock for the genus. In *Okeechobea* species, the apical sulcus is open; the species are mostly inflated, fragile and have varying aperture widths. They appear to be more closely aligned with *Calusacypraea*, in which case, *C. polkensis* could plausibly be considered the possible predecessor.

ACKNOWLEDGEMENTS

This article is based in large part on the related collective works of Dr. Edward J. Petuch which encapsulate his 45 years of field and academic work with the geology, paleogeography and fossil fauna of Florida.

REFERENCES

Daughenbaugh, J.D. 2019. The Fossil Cypraeidae of the Buckingham Member (Unit 10), Tamiami Formation of Southern Florida: (Mollusca: Gastropoda: Cypraeidae). The Festivus 51:54-61.

Gardner, J. 1948. Mollusca from the Miocene and lower Pliocene of Virginia and North Carolina, Part 2, Scaphopoda and Gastropoda. Department of the Interior, Professional Paper 199-B, United States Government Printing Office, Washington, D. C. 213-214, pl. 29, figs. 2, 7.

Hunter, M.E. 1968. Molluscan Guide Fossils in Late Miocene Sediments of Southern Florida. Transactions of the Gulf Coast Association of Geological Studies, Publication 20, pp. 61-88.

Mansfield, W.C. 1930. Miocene Gastropods and Scaphopods of the Choctawhatchee Formation of Florida. Florida State Geological Survey – Volume 3:94.

Mansfield, W.C. 1931. Some Tertiary Mollusks from Southern Florida. Proceedings of the U.S. National Museum 79(21):1-12.

Missimer, T.M. 1992. Stratigraphic relationships of sediment facies in the Tamiami Formation of southwest Florida: proposed transformational correlations, in Scott, T. M. and Allmon, W. D., Eds. The Plio-Pleisticene Stratigraphy and Paleontology of Southern Florida. Special Publication 36, Florida Geological Survey, Florida Department of Natural Resources, Tallahassee, Florida, pp. 63-92.

Olsson, A.A. & A. Harbison. 1953.. Pliocene Mollusca of Southern Florida, with special reference to those from North Saint Petersburg. Monographs of the Academy of Natural Sciences of Philadelphia, 8:1-361.

Olsson, A.A. & R.E. Petit. 1964. Some Neogene Mollusca from Florida and the Carolinas. Bulletins of American Paleontology 47(217):509-575.

Petuch, E.J. 1982. Notes on the Molluscan Paleontology of the Pinecrest Beds at Sarasota, Florida. Proceedings of the Academy of Natural Sciences of Philadelphia 134:12-30.

Petuch, E.J. 1986. The Pliocene Reefs of Miami: Their Significance in the evolution of the Atlantic Coastal Ridge, southeastern Florida, USA. Journal of Coastal Research 2(4):391-408.

Petuch, E.J. 1991. New Gastropods from the Plio-Pleistocene of Southwestern Florida and the Everglades Basin. Special Publication 1. W.H. Dall Paleontological Research Center, Florida Atlantic University, 85 pp.

Petuch, E.J. 1994. Atlas of Florida Fossil Shells (Pliocene and Pleistocene Marine Gastropods). The Graves Museum of Natural History, Dania, Florida and Spectrum Press, Chicago, Illinois. 394 pp.

Petuch, E.J. 1996. *Calusacypraea*, a new, possibly neotenic, genus of cowries from the Pliocene of southern Florida. The Nautilus 110(1):17-21.

Petuch, E.J. 1997. A new gastropod fauna from an Oligocene back-reef lagoonal environment in west central Florida. The Nautilus 110(4):122-138.

Petuch, E.J. 1998. New Cowries from the Myakka Lagoon System and the Everglades Pseudoatoll (Pliocene Okeechobean Sea). La Conchiglia 30(288):27-37.

Petuch, E.J. 2004. Cenozoic Seas: The View from Eastern North America. CRC Press, Boca Raton, Florida. 308 pp.

Petuch, E.J. 2008. The Geology of the Florida Keys and the Everglades: An Illustrated Field Guide to Florida's Hidden Beauty. Thomson-Cengage Publishers, Mason, Ohio. 84 pp.

Petuch, E.J. & C.E. Roberts. 2007. The Geology of the Everglades and Adjacent Areas. CRC Press, Boca Raton, Florida. 212 pp.

Petuch, E.J. & M. Drolshagen. 2011. Compendium Of Florida Fossil Shells, Volume I (Middle Miocene to Late Pleistocene Marine Gastropods of the Everglades and Adjacent Areas: Families Strombidae, Cypraeidae, Ovulidae, Eocypraeidae, Triviidae, Conidae and Conilithidae). MdM Publishers. Liuzhou, Guangxi, China. 412 pp.

Petuch, E.J., D.P. Berschauer, & R.F. Myers. 2018. Jewels of the Everglades, The Fossil Cowries of Southern Florida. San Diego Shell Club, Inc., Encinitas, California. 256 pp.

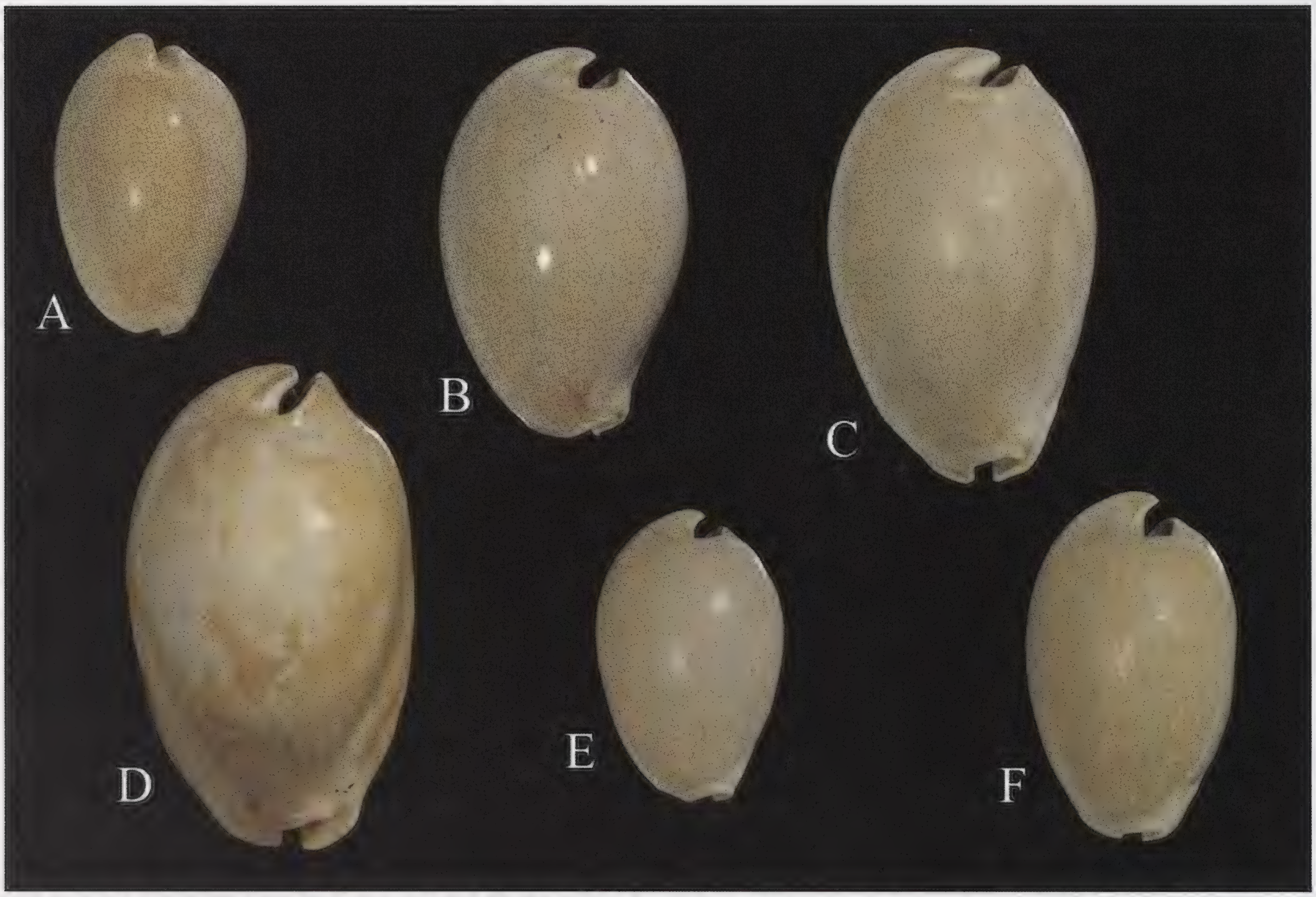


Figure 1. Kissimmee River Valley restricted (Unit 7 equivalent). A = *Akleistostoma (Ingramicypraea) highlandensis* Petuch and Drolshagen, 2011, length 50.9 mm; **B** = *Akleistostoma (Olssonicypraea) hughesi* (Olsson and Petit, 1964), length 64.6 mm; **C** = *Pahayokea kissimmeensis* (Petuch, 1994), length 71.5 mm; **D** = *Pahayokea (Kissimmecypraea) transitoria* (Olsson and Petit, 1964), length 81.4 mm; **E** = *Okeechobea osceolai* Petuch and Drolshagen, 2011, length 48.3 mm; **F** = *Okeechobea (Yeehawcypraea) bartoni* Petuch and Drolshagen, 2011, length 57.9 mm.

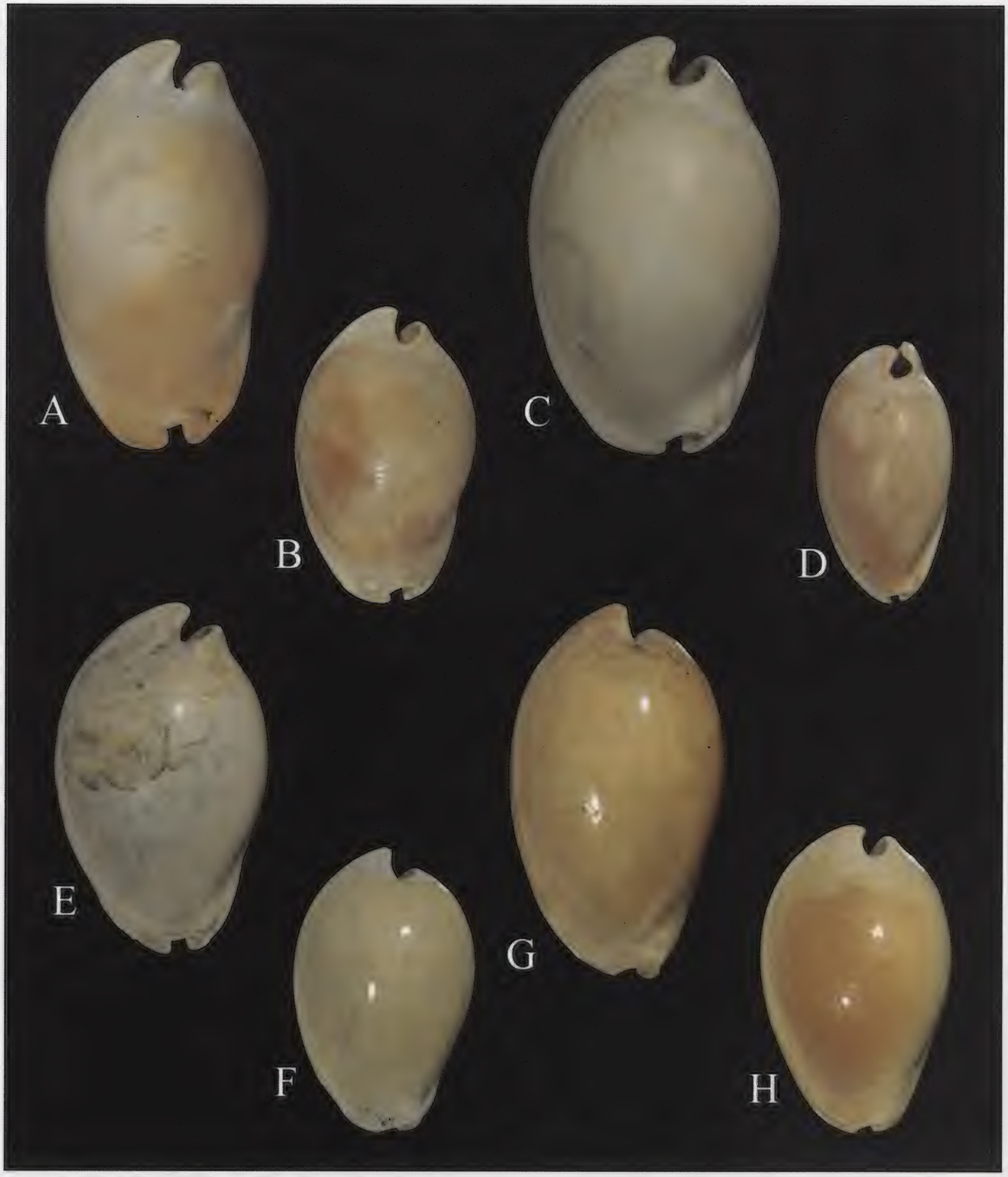
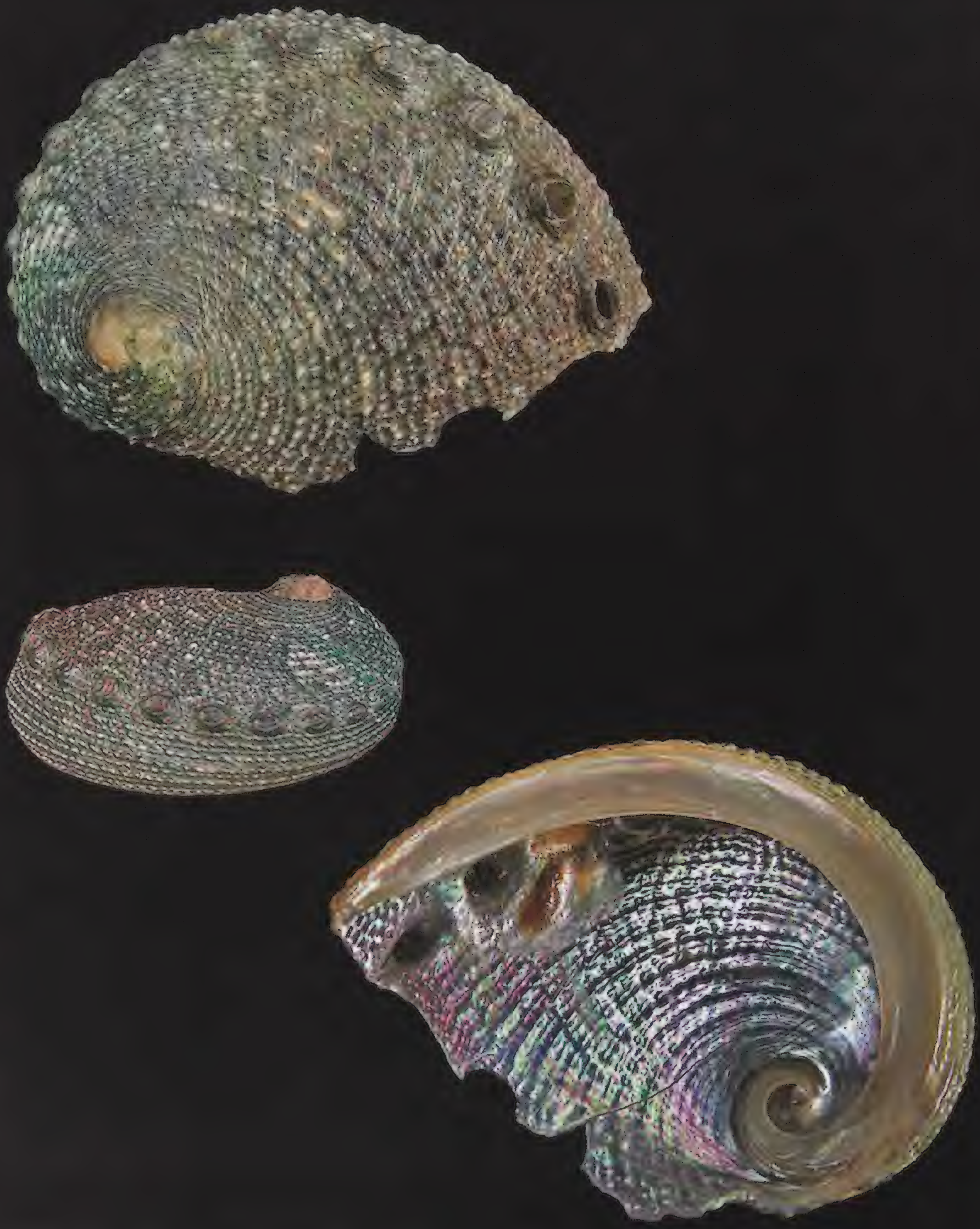


Figure 2. Myakka Lagoon System (Sarasota) Unit 7. **A** = *Akleistostoma floridana* (Mansfield, 1931), length 78.5 mm; **B** = *Akleistostoma patula* Petuch and Drolshagen, 2011, length 57.3 mm; **C**= *Akleistostoma (Mansfieldicypraea) rugostoma* Petuch and Drolshagen, 2011, length 79.4 mm; **D** = *Siphocypraea (Seminolecypraea) trippeana* Parodiz, 1988, length 50.7 mm; **E**= *Pahayokea (Gardnericypraea) mansfieldi* (Petuch, 1998), length 67.3 mm; **F** = *Calusacypraea globulina* Petuch, 2004, length 54.3 mm; **G** = *Calusacypraea (Myakkacypraea) briani* (Petuch 1996), length 71.1 mm; **H** = *Pseudadusta hertweckorum* (Petuch, 1991), length 58.6 mm.

ISSN 0738-9388



Haliotis drogini Owen & Reitz, 2012. Cocos Island, Costa Rica. 25 mm. 200 m. Holotype. World's rarest *Haliotis* species. Three specimens known as of April, 2019.

ISSN 0738-9388

Have a shell collection you would like to donate to The San Diego Shell Club?

The San Diego Shell Club is interested in your shell collection. As a 501c(3) organization, all donations to our Club may provide a tax write-off. When we receive a donation we provide a letter describing the items that may be used when filing your taxes. While we cannot provide a value, donations of up to $5,000 do not require a written appraisal. Since tax laws change regularly we recommend that you check with your tax accountant before relying on any information provided here.

We are interested in all types of shells, marine or land and all genera and species, including books on shells as well as items related to shells such as artwork, storage cases and tools. Your donated items will be used to generate income to support the Club's efforts in continuing Public education about shells and conservation of marine life throughout the world. If you would like to donate, please contact David Waller, SDSC Acquisition Chairperson, at dwaller@dbwipmg.com to schedule a time to discuss charitable gifting.

CLUB NEWS

2019 February General Meeting

Our February general meeting was held on February 16, 2019, at David and Felicia Berschauer's home in Laguna Hills. We had a good turn out with members from several counties present, and a wonderful spread of dishes provided by members. There were also shells for show, trade and sale. Lisa Dawn Lindahl gave a presentation on inherited shell collections including sage advice about what "not to do".

2019 March General Meeting

Our March general meeting was held on March 16, 2019, at Todd and Jill Spofford's home in San Diego. The speaker was Dewitt Rathbun who gave a presentation about shell collecting along the sparsely populated coast of northwest Australia when he and his wife were stationed here in the early 1960s. We had a good turn out with over a dozen members present and a wonderful spread of dishes provided by members. There were also shells for show, trade and sale.

2019 April Potluck and Auction

Our Club's annual spring shell auction was held on April 20, 2019 in its usual location at Wes Farmer's condominium clubhouse in San Diego near Montgomery Field. In addition to the 140 lots of gorgeous specimen shells we had a silent auction, a five dollar table, and a dollar table. There was a sumptuous spread of potluck dishes brought by members, beverages and the famous "Dave's punch" like Dave Mulliner used to make. The potluck and auction had a large turnout, and some good natured haggling over shells in the oral auction. Everyone had a good time and most members present walked away with some new prizes to add to their collections.

THE FOURTH ANNUAL

WEST COAST

Shell Show

SPONSORED BY THE

San Diego Shell Club

AUGUST 24-25 2019

CASA DEL PRADO

1650 EL PRADO, BALBOA PARK, SAN DIEGO, CA 92101

ROOM 101 | SATURDAY 9^{A}–7^{P} | SUNDAY 9^{A}–7^{P}

ISSN 0738-9388

Shelling on our dream trip to Australia

Robyn Waayers
5893 Mountain Meadow Road, Julian, CA 92036
rwaayers@gmail.com

In July, my husband and I finally actualized our persistent dream of visiting Australia. With some Aussie Waayers (distant cousins) ready to meet the American side of the family, and birds, mammals and landscapes waiting to be seen and photographed, the shelling was the perfect "icing on the cake" to the trip. Note the species list of self-collected shells at the end of the article, as well as photos of the better specimens that were found (see Figure 8).

July is wintertime down under, and we started our three-week adventure in the southern part of the continent, in the state of Victoria. After a week of time spent inland, we headed south to the coast and spent four days in the town of Apollo Bay, about 170 kilometers (or a bit over 100 miles) southwest of Melbourne. The area is a mixture of sandy beaches and intertidal areas. Live collecting with a permit is quite limited in Victoria, and in the end I stuck to collection of empty shells on appropriate beaches. The surf in winter in this area can be very heavy, so a sharp eye was kept on the waves whenever exploring near the edge of the water. The reality of empty-shell collecting in an area with rough surf (sounds a bit like southern California, doesn't it?) is that many broken or damaged shells are found. I saw enticing but chipped *Scutus antipodes* Montfort, 1810 shells, as well as the large turbinid, *Lunella undulata* (Lightfoot, 1786). Since I am interested in limpets at the moment, there was much satisfaction to be found in small catch basins associated with sandy and rocky intertidal areas (Figure 1), where the empty shells of several limpet species were found, including the nacellids *Cellana tramoserica* (Holten, 1802), *Patelloida alticostata* (Angas, 1865), *Patelloida latistrigata* (Angas, 1865) *Scutellastra peronii* (Blainville, 1825), and the fissurellids *Amblychilepas javanicensis* (Lamarck, 1822), *Amblychilepas nigrita* (G. B. Sowerby I, 1835), *Emarginula dilecta* A. Adams, 1852, and *Montfortula rugosa* (Quoy & Gaimard, 1834).

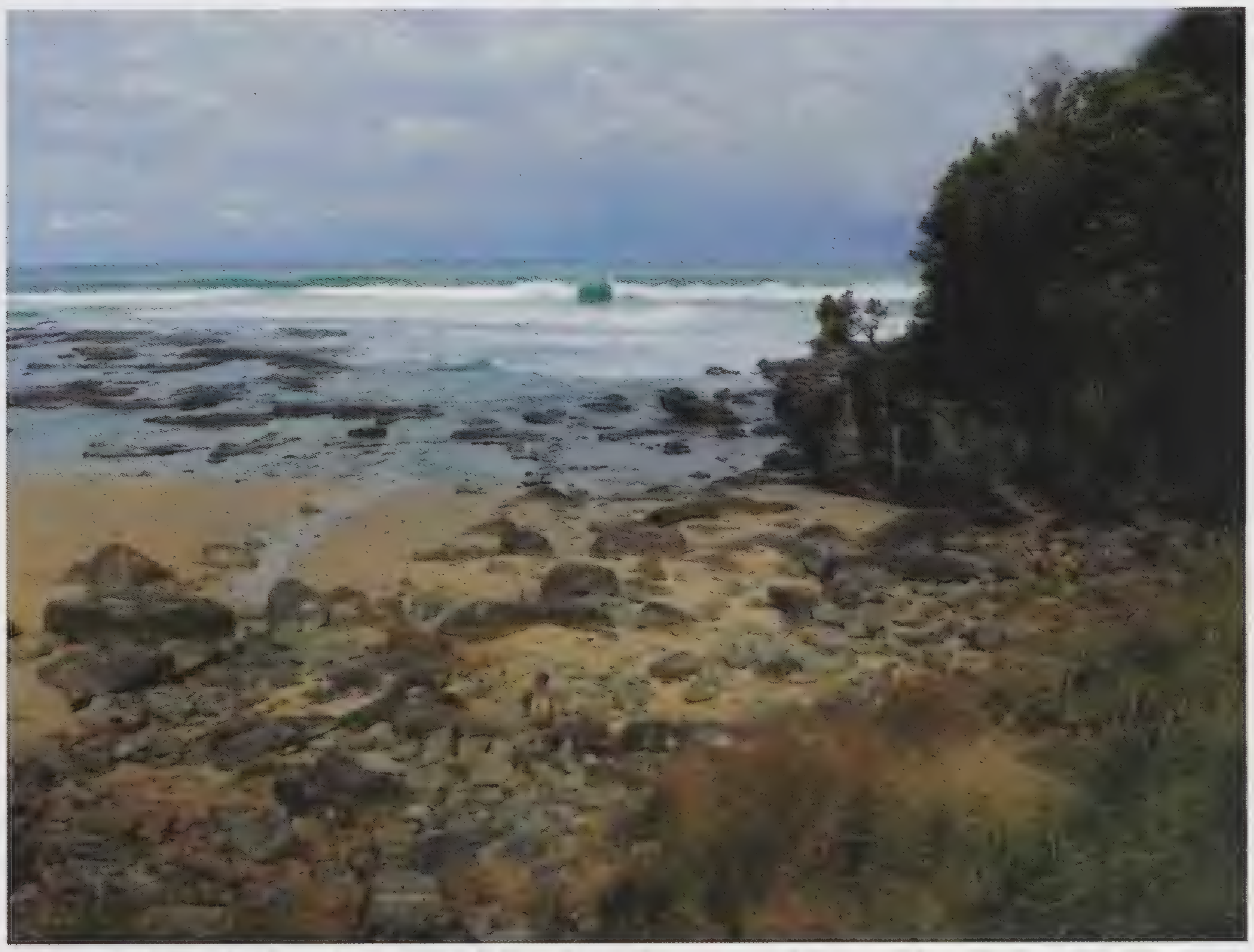


Figure 1. Typical rocky intertidal and sandy mix on Victoria beaches.

Cellana tramoserica (Holten, 1802) was by far the most commonly observed limpet species, with some beautiful live specimens seen attached to rocks in the intertidal zone, as well (Figure 2).

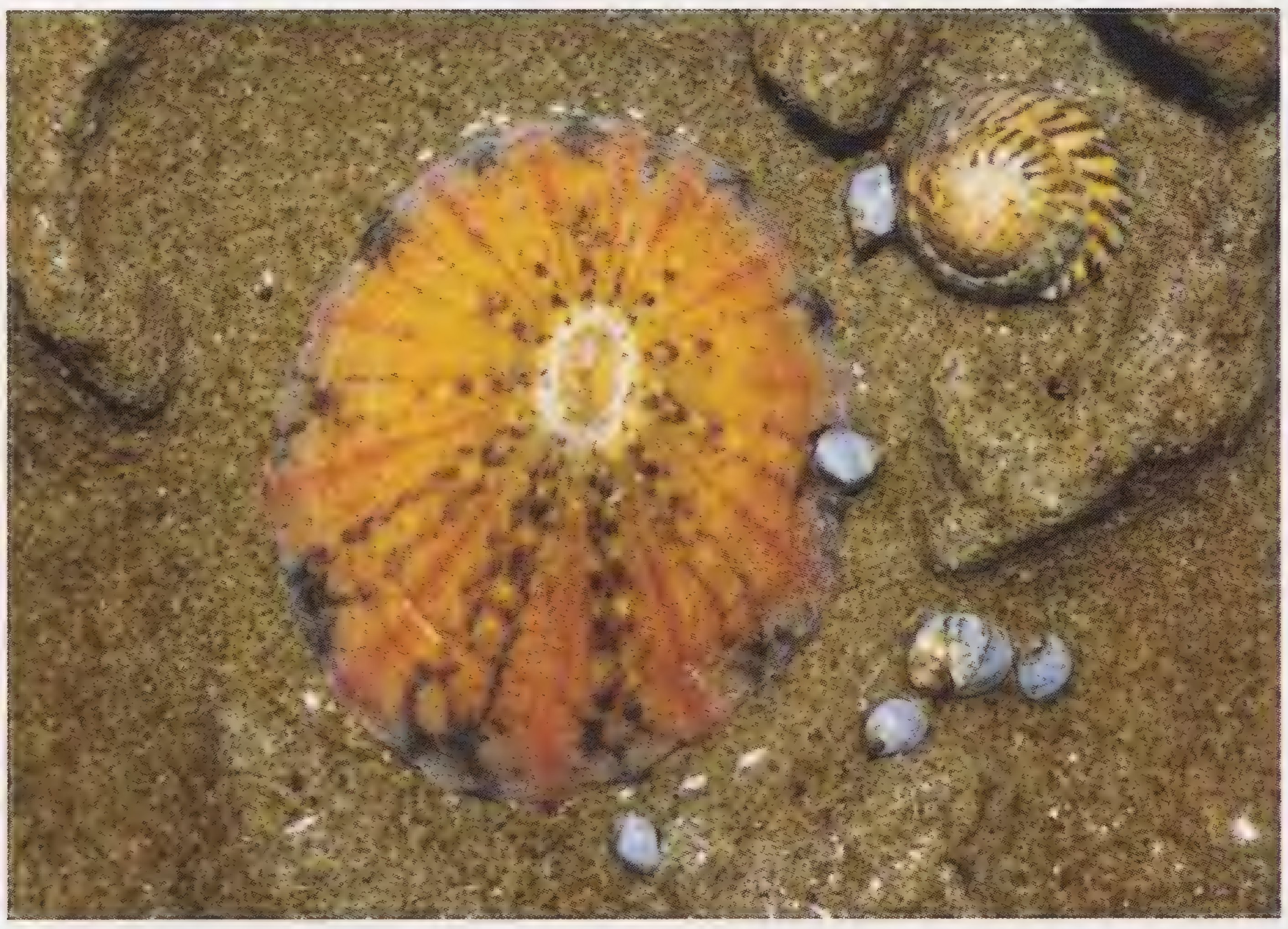


Figure 2. Live *Cellana tramoserica* on rock in the intertidal zone, Apollo Bay, Victoria.

After departing the southern coast, we flew north to Cairns, Queensland, a tropical locale. Winter here was mild and mercifully lacking in rain. After temperatures in the 50s and 60s (Fahrenheit) in Victoria, the typical daytime temperatures of 70s and low 80s made for perfect T-shirt weather and comfortable shelling. Queensland has a very different attitude (and regulations) about live collection of mollusks, so this was a new option in places that were not marine reserves or protected areas.

We spent a week in Queensland and two of those days involved boat trips to the Great Barrier Reef. The reality of these boat trips is that they are around 2-plus hours one way (so 4-5 hours of the day are spent travelling). We visited Michaelmas and Hastings reefs on the first day and then took a day off before making the second reef trip, which visited Saxon and Hastings reefs. The reef was exciting for us as it was a brand new experience, but bleached coral was evident everywhere we went. Nonetheless, many healthy areas of coral and its associated marine life were seen as well. Of course no shell collecting can be done on these parts of the reef, but I did photograph some amazing mollusks. The Giant Clam, *Tridacna gigas* (Linnaeus, 1758) was quite abundant (Figure 3), and I even saw an old, empty shell, at least a meter in length! (Figure 4)

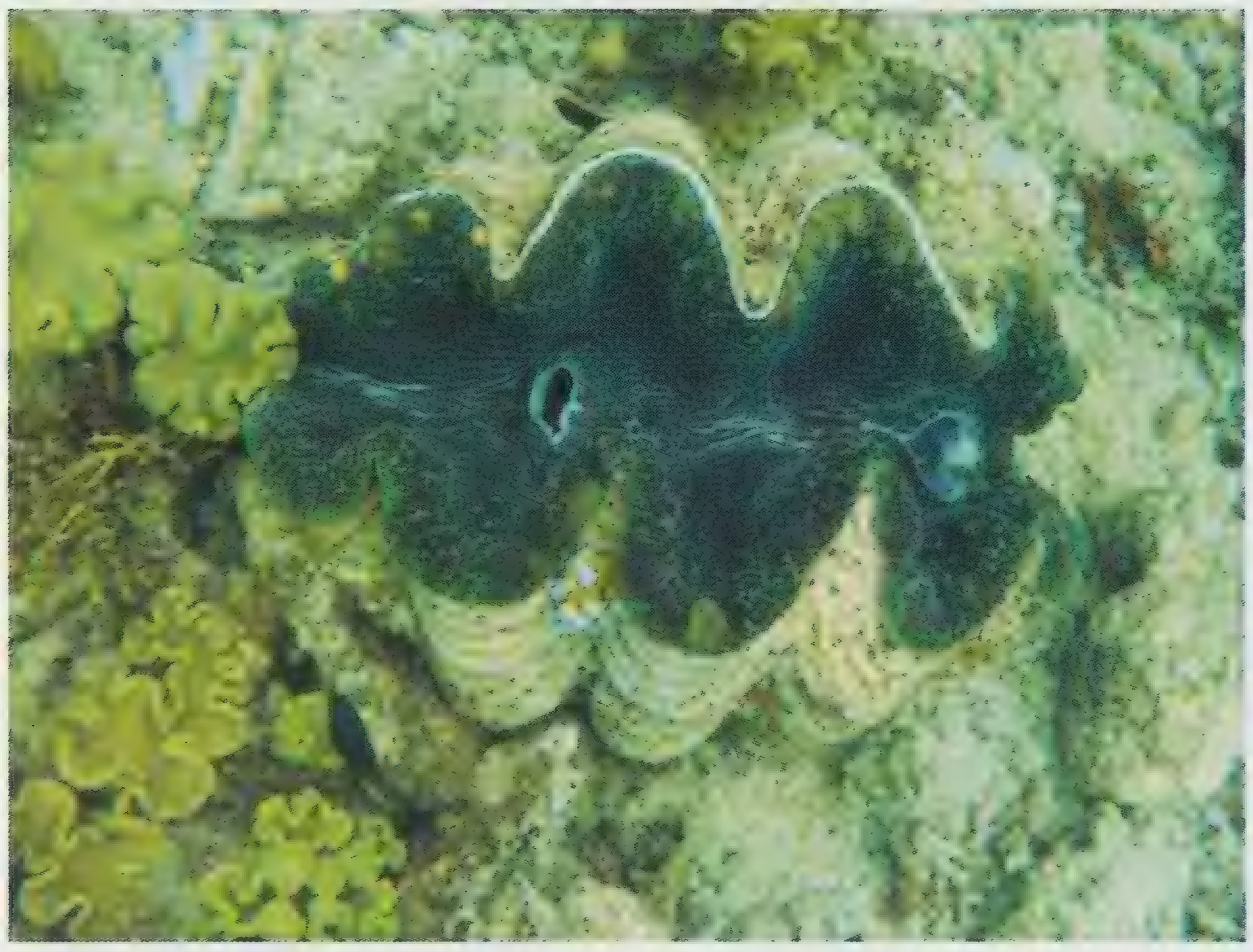


Figure 3. Live *Tridacna gigas*, between 1 and 1.2 meters in length, on Hastings Reef, Great Barrier Reef.

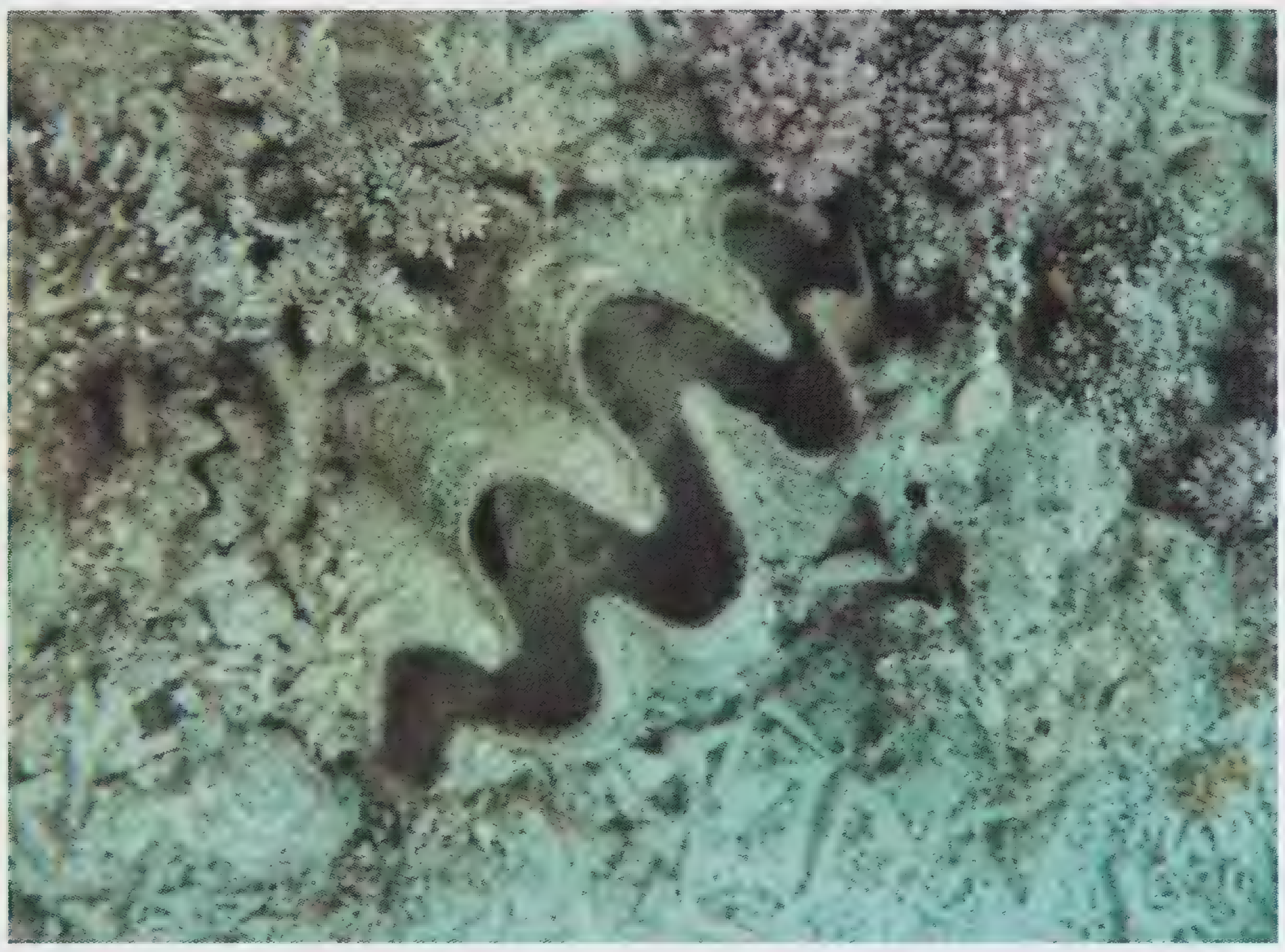


Figure 4. Dead *Tridacna gigas*. Hastings Reef, Great Barrier Reef.

In the city of Cairns, we stayed in lodgings in Yorkeys Knob, slightly north of the city center. The mainland beaches of Queensland are not necessarily known for shelling, but Yorkeys Knob beach, just a block or so from our lodging, was quite satisfying at low tide. Walking south from Sims Esplanade at low tide, the sand bars are revealed. Now I had read extensively about the risk of crocodile attacks in Queensland and was equipped with a healthy sense of caution. I had decided in advance to never wade IN the water, but was surprised to see many kite surfers enjoying the afternoon trade winds, and sometimes they fell into the small waves! Apparently there has not been a significant croc attack on this beach since the 1990s and so my fears were slightly allayed. I still stuck to my "rule" of not wading, though. In and on the sand I found several specimens of *Phalium areola* (Linnaeus, 1758), as well as multiple *Nassarius* species, a large *Donax* species (*Donax cuneatus* Linnaeus, 1758) which was very different from our smaller ones here in California, sundial shells, and tests of sand dollars, among others.

Crocs are more of an issue the further north one ventures from Cairns, and we did just that to visit some other beaches at low tide. I tried to not get too close to the water's edge in this territory, and never waded in the lagoons which looked so tempting, shell-wise. Signs were posted reminding visitors of the crocs' presence. (Figure 5)

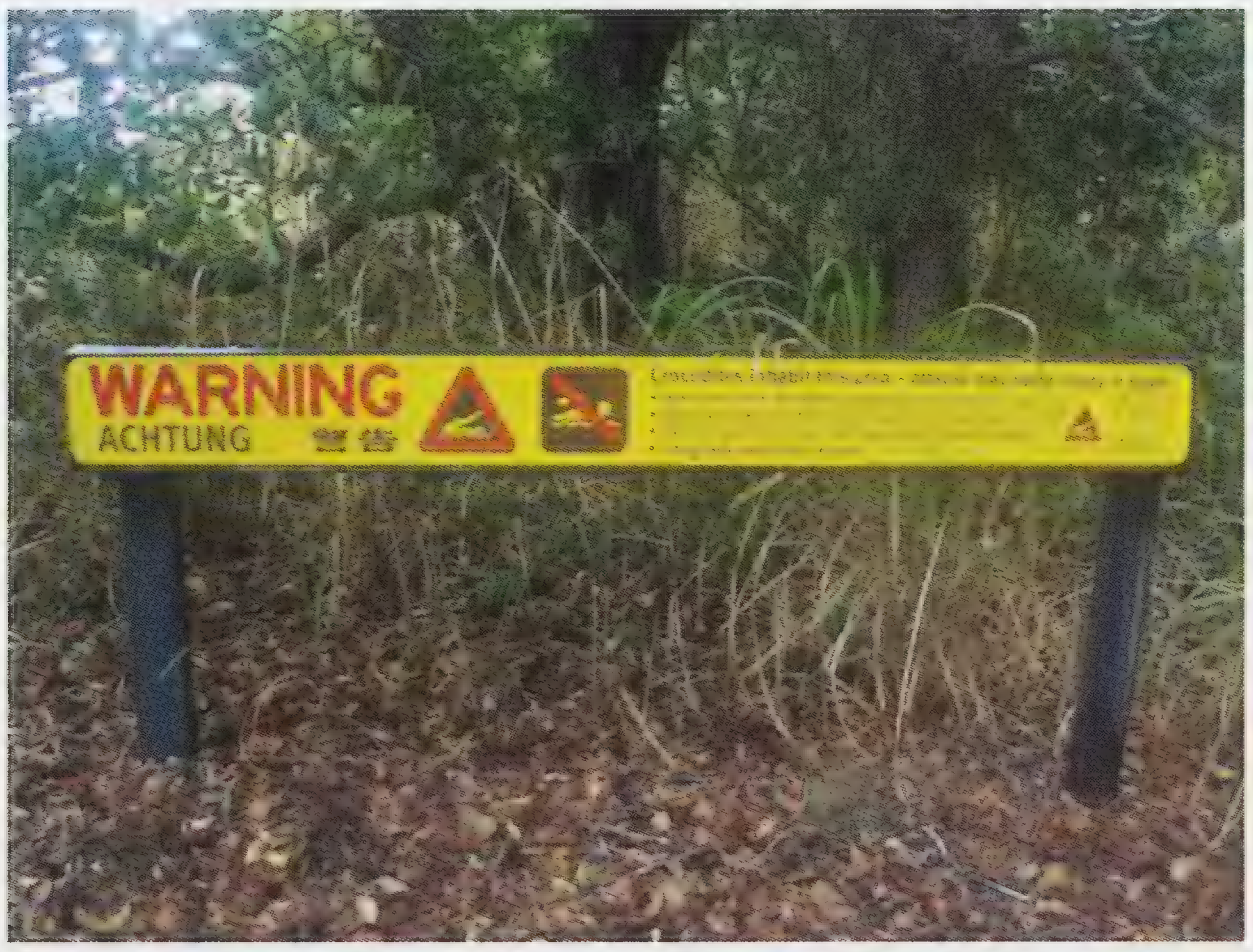


Figure 5. Crocodile warning sign, Wangetti Beach, Queensland.

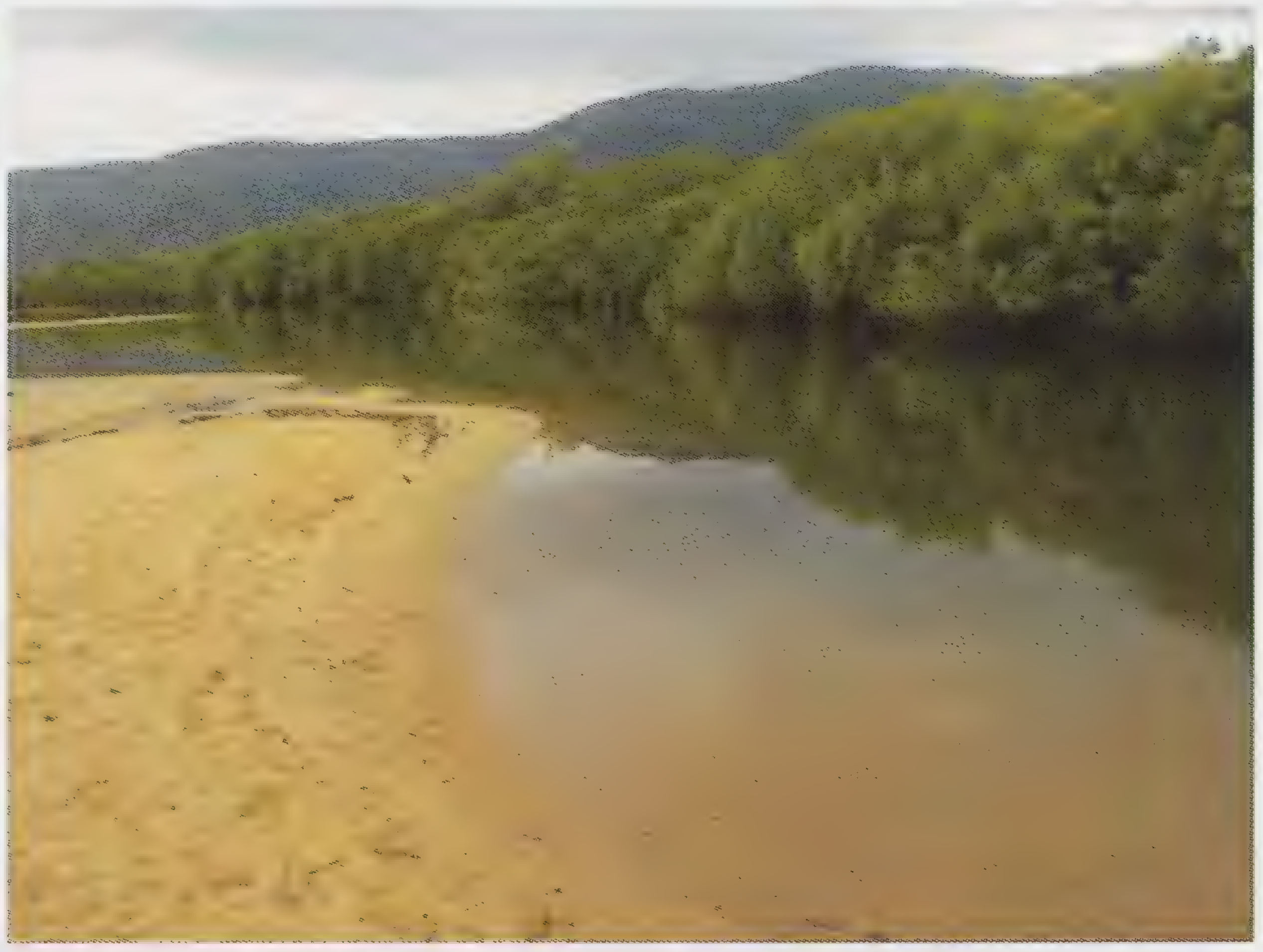


Figure 6. Typical lagoon adjacent to ocean beach, Queensland.

Nice shells were to be found in the wrack lines of these beaches, though, including sundials, an interesting "hairy" cockle species (*Maoricardium pseudolatum* Voskuil & Onverwagt, 1991), and cones and cowries that were unfortunately too wave-worn to keep.

Three species of nerite (*Nerita albicilla* Linnaeus, 1758, *Nerita balteata* Reeve, 1855, and *Nerita chamaeleon* Linnaeus, 1758), two species of periwinkles (*Littorinopsis scabra* (Linnaeus, 1758) and *Planaxis sulcatus* (Born, 1778)), as well as *Siphonaria laciniosa* (Linnaeus, 1758) were found in rocky intertidal areas in Queensland.

Figure 7. Sandy beach, north of Cairns, Queensland. Crowds were not a problem on these beaches!

Since we divided our time on this trip between bird photography, family activities and driving from place to place, I know that if I were to revisit some of these Australian locations with shell collecting as the primary activity, that I would have a much larger list of self-collected species. If I could offer advice to those shelling in the places that we visited, I highly recommend the area south of Sims Esplanade in Yorkeys Knob in Cairns (at the lowest tide possible) to find shells on the exposed sand bars. And in Victoria, I suspect that summer might provide better conditions along the coast, as wading and snorkeling are much more viable options than in winter when we visited.

LIST OF SPECIES SELF-COLLECTED IN AUSTRALIA (alphabetical by family/genus):

Victoria:

BUCCINIDAE
- *Cominella lineolata* (Lamarck, 1816)

FISSURELLIDAE
- *Amblychilepas javanicensis* (Lamarck, 1822)
- *Amblychilepas nigrita* (G. B. Sowerby I, 1835)
- *Emarginula dilecta* A. Adams, 1852
- *Montfortula rugosa* (Quoy & Gaimard, 1834)

LITTORINIDAE
- *Bembicium nanum* (Lamarck, 1822)

MARGINELLIDAE
- *Mesoginella turbinata* (G.B. Sowerby II, 1846)

MURICIDAE
- *Bedeva vinosa* (Lamarck, 1822)

NERITIDAE
- *Nerita atramentosa* Reeve, 1855

NACELLIDAE
- *Cellana tramoserica* (Holten, 1802)
- *Patelloida alticostata* (Angas, 1865)
- *Patelloida latistrigata* (Angas, 1865)
- *Scutellastra peronii* (Blainville, 1825)

SIPHONARIIDAE
- *Siphonaria diemenensis* Quoy & Gaimard, 1833
- *Siphonaria funiculata* Reeve, 1856

TRIVIIDAE
  Ellatrivia merces (Iredale, 1924)
TROCHIDAE
  Austrocochlea concamerata (Wood, 1828)
  Austrocochlea constricta (Lamarck, 1822)
  Chlorodiloma adelaidae (Philippi, 1849)
  Clanculus plebejus (Philippi, 1851)
  Prothalotia pulcherrima (W. Wood, 1828)

Queensland:
ARCHITECTONICIDAE
  Architectonica perdix (Hinds, 1844)
  Architectonica perspectiva (Linnaeus, 1758)
BURSIDAE
  Bufonaria rana (Linnaeus, 1758)
CARDIIDAE
  Maoricardium pseudolatum Voskuil & Onverwagt, 1991
CASSIDAE
  Phalium areola (Linnaeus, 1758)
DONACIDAE
  Donax cuneatus Linnaeus, 1758
LITTORINIIDAE
  Littorinopsis scabra (Linnaeus, 1758)
MURICIDAE
  Purpura bufo Lamarck, 1822
NACELLIDAE
  Cellana conciliata Iredale, 1940
NASSARIIDAE
  Nassarius algidus (Reeve, 1853)
  Nassarius dorsatus (Röding, 1798)
NATICIDAE
  Conuber conicum (Lamarck, 1822)
NERITIDAE
  Nerita albicilla Linnaeus, 1758
  Nerita balteata Reeve, 1855
  Nerita chamaeleon Linnaeus, 1758
OLIVIDAE
  Oliva oliva (Linnaeus, 1758)
PLANAXIDAE
  Planaxis sulcatus (Born, 1778)
SIPHONARIIDAE
  Siphonaria laciniosa (Linnaeus, 1758)
SOLENIDAE
  Solen sp. Linnaeus, 1758
STROMBIDAE
  Laevistrombus canarium (Linnaeus, 1758)
TEREBRIDAE
  Cinguloterebra anilis (Röding, 1798)

Some of the best specimens collected on the trip are grouped in Figure 8. below:

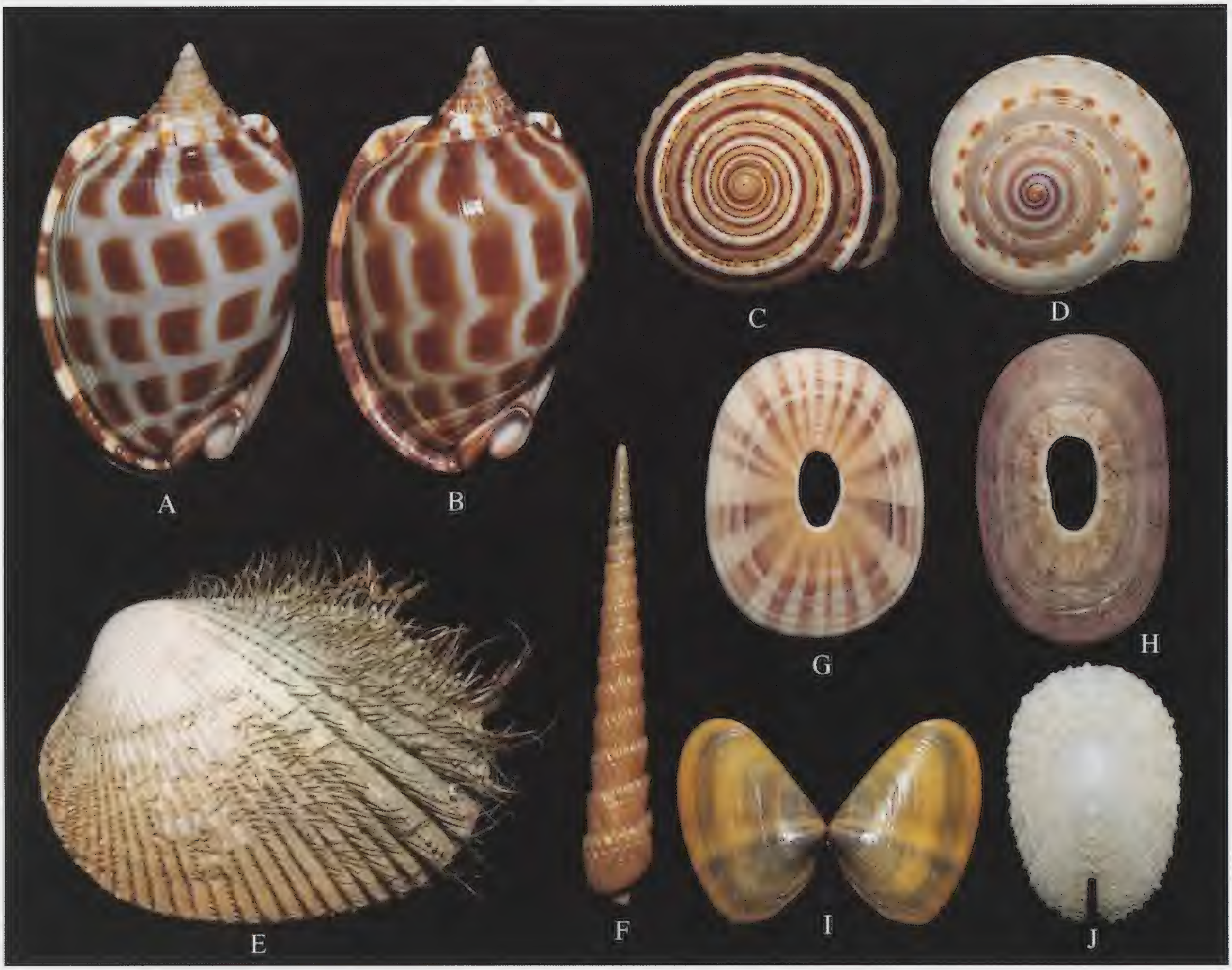


Figure 8. Selected specimens collected in Victoria and Queensland (not to scale).
A. and B.: *Phalium areola* (Linnaeus, 1758), showing pattern variability. A: 45 mm, B: 49 mm; **C.:** *Architectonica perspectiva* (Linnaeus, 1758), 28 mm; **D.:** *Architectonica perdix* (Hinds, 1844), 25 mm; **E.:** *Maoricardium pseudolatum* Voskuil & Onverwagt, 1991, 40 mm wide; **F.:** *Cinguloterebra anilis* (Röding, 1798), 40 mm; **G.:** *Amblychilepas javanicensis* (Lamarck, 1822), 24 mm; **H.:** *Amblychilepas nigrita* (G. B. Sowerby I, 1835), 17 mm; **I.:** *Donax cuneatus* Linnaeus, 1758, 28 mm; **J.:** *Emarginula dilecta* A. Adams, 1852, 13 mm.

Order your San Diego Shell Club collectible mugs in our new design for 2018 - while supplies last. $15 each, plus 8% sales tax and shipping at actual costs. These 11 ounce mugs are great for coffee, tea or hot cocoa anytime. We accept PayPal for your convenience. See www.sandiegoshellclub.com

ISSN 0738-9388

Volume: 51 THE FESTIVUS ISSUE 2

Eighteen Months in Martinique

David Touitou
20 Rue De La Gypiere
83790 Pignans, France
pharma.collo@gmail.com

I had the chance to live eighteen months on the French island of Martinique. I was 25 years old and I was just finishing my doctorate in pharmacy. I decided to do a long military service in order to get a job in the islands. I arrived there as a collector of cowries in 2000. My late friend Roger Rault, my mentor at the time, had often shown me his collection of cones and pushed me to collect the cones for their great variability. In spite, of that I was at the time still crazy of cowries. I started to explore the south of Martinique because I lived in Anse à l'Âne. I would always remember my first snorkle. I did not have a car when I arrived and my host took me to Anses d'Arlets, a cute little beach open to the open sea. There is a pontoon and on the right a group of rocks about ten meters from the beach. I had little time and started exploring this small rocky area. This is where I found my first cowrie *Luria cinerea* (Gmelin, 1791)! A freshly dead and virtually black shell, amazing! So different from the ones I was given, gray in color. As you can imagine, the dark color fades with time. But it's amazing to see such a difference between a fresh shell and a specimen taken out of the water for several years.

In Martinique, *Luria cinerea* and *Luria cinerea brasilensis* (Lorenz, 2002) are common species that live during the day in the crevices of the rocks but also in large gray sponges from the first meters. I was lucky to find hundreds of specimens of all sizes dead and in excellent condition, especially near the lairs of octopus. Of course, there is also the *Naria acicularis* (Gmelin, 1791), which is also common and shares the habitat of the previous two. On the other hand, it is much harder to harvest the other two species of cowries: *Macrocypraea zebra* (Linnaeus, 1758) and *Propustularia surinamensis* (G. Perry, 1811). I found only one dead *Macrocypraea zebra* in excellent condition and of good size at Anse Dufour. It is dark in color and is a real gem. For the story, I found it shortly before my departure during one of my last launches. I took it as a farewell gift from the island (or possibly I found it because Martinique was happy that a collector is leaving ...). Regarding *Propustularia surinamensis*, I found several dead specimens scuba diving but it is my diving partner Fabien Goutal who, during a dive to the north from the beach, who found our only living specimen ... and what a magnificent specimen! A sustained color! For the story, Chris Meyer contacted us to find out if we still had the living specimen (following the publication of my article on my website www.seashell-collector.com) and to send him a sample for DNA analysis. Fabien had already returned to France and tapping on his shell, managed to get some powder that he sent to Chris who managed to accomplish the unthinkable: the molecular analysis on this sample powder!

Very quickly I started to come across cones - even though I did not really know where to look for them at the start. For images of the cone species discussed below see Figures 1 through 5 at the end of this article. It was an unknown land for me. The first specimens I was able to observe were *Stephanoconus regius* (Gmelin, 1791) and *Gladioconus mus* (Hwass in Bruguière, 1792), both living in shallow water, hidden in the crevices of the rock and under or around the pieces of dead coral and rocks. Next, I came across *Dauciconus daucus* (Hwass in Bruguière, 1792) which is easier to find at

10-20 m hidden among the algae in which it is camouflaged with wonder because of its algal-like tuffed periostracum. Of course on the Atlantic coast I collected the small cones such as *Perplexiconus puncticulatus columba* (Hwass in Bruguière, 1792) found dead o the beach during our weekend bivouacs without really looking for living specimens. It must be said that when we start collecting cones, we are not necessarily attracted by the smaller species. Quickly, I was intrigued by a small brown cone that I always found dead and which was often misidentified as *Gradiconus burryae* (Clench, 1942). I also noticed the error in this cone's identification, and at the time, I contacted several specialists including Edward Petuch to correct this anomaly. I am very happy that many years later this species was finally described: *Poremskiconus colombi* (Monnier & Limpalaër, 2012).

When I started scuba diving there, too late I must admit, I came across a multitude of new incredible species: *Dauciconus boui* (da Motta, 1988), dead and alive, *Dauciconus norai* (da Motta & G. Raybaudi Massilia, 1992) dead, *Dauciconus jacquescolombi* (Monnier & Limpalaër, 2016) two dead specimens, *Chelyconus ermineus* (Born, 1778) also dead, *Atlanticonus granulatus* (Linnaeus, 1758) dead, and *Jaspidiconus mindanus* (Hwass in Bruguiere, 1792) alive and dead. I have never seen a single specimen of *Lindaconus spurius* (Gmelin, 1791) either alive or dead. For many months I searched for all the local variations of *Stephanoconus regius* (the King's cone) because I quickly fell in love with this cone species which has what seems to be a thousand colors and patterns! Forgetting in passing to go diving in a club and visit more important finds. This allowed me to harvest many specimens of all sizes, some of which are unique shells! I present you photographs of some of these specimens in the figures at the end of this article. We can distinguish several main variations that seem to result from diet. Indeed, there are species that feed on fireworms which are quite common in Martinique. These worms can be of several colors and it is possible that it is this characteristic that causes so many variations in *S. regius*. In fact, we can classify the King's cones in several categories:

- Light cones whose shell is dominated by white and sometimes pink;
- Dark cones whose shell is dominated by dark brown or black;
- The yellow cones called "*citrinus*";
- The orange cones also called "*citrinus*";
- The light brown cones also called "*citrinus*";
- The blue cones.

Of course, there are also many intermediate variations that have for example a face "*citrinus*" and a non-face "*citrinus*".

I had a second "love at first sight" feeling much later when I found my first *Dauciconus boui* because, once again, this cone has such delicate patterns and its variable colors. Even though it is possible to find this cone as shallow as ten meters, it generally occurs at deeper depths. Its small size, strong encrustation, and tuffed periostracum make this a difficult species to spot. In addition to coming across the living species, I have found very beautiful dead specimens several times. It appears that this species is restricted to the south of the island.

Since living in Martinique I traveled to Venezuela but I have never found cones, only a huge representative of the family Ranelidae, a pretty yellow volute, and some cowries including a "sick" *cinera* and dwarf *zebra*. It must be said that we swam only one afternoon!

I was able to spend a few days in Guadeloupe and Dominica, but I found nothing more than in Martinique.

On the other hand, the two excursions to the Grenadines were extraordinary, both in the scenery and the shells that I found there. Although I left with non-collector friends, I was able to find time to swim at each stopover of our boat. The first time, I was able to find my first *Tenorioconus dominicanus* (Hwass in Bruguière, 1792) during a night free dive just when I was going to give up! I went out with a colleague who wanted to try to swim at night, we only had a lamp for two, the water was cool and there was about 6-8 meters of water. Of course it was exhausting. It was necessary to go down and then scour the bottom in search of a possible cone. After an hour, my energy was spent. What a surprise when I held my breath as my light beam illuminated this majestic cone!

During the second cruise, I would have the chance to collect three of these cones at night. Each of these cones are beautiful specimens of very good size. It is in this respect sad to see small immature specimens of these cones at the shell shows for sale that are sold cheaply. I tell you frankly, it is shameful to over collect specimens of these majestic cones in this way as it destroys their populations! Let them grow! During this expedition I also found three *ermineus* cones including a freak specimen, *pseudaurantius* cones, and a dead *granulatus* cone. One thing is certain, a passage through the Caribbean zone does not leave you without memories! It was eighteen months filled with unforgettable discoveries in environments where endemism is very strong and the sea is not very dangerous. I hope I can return one day!

https://www.seashell-collector.com/
https://www.youtube.com/SeashellsMineralsChannel
https://www.facebook.com/seashell.channel
https://www.instagram.com/seashell_channel/

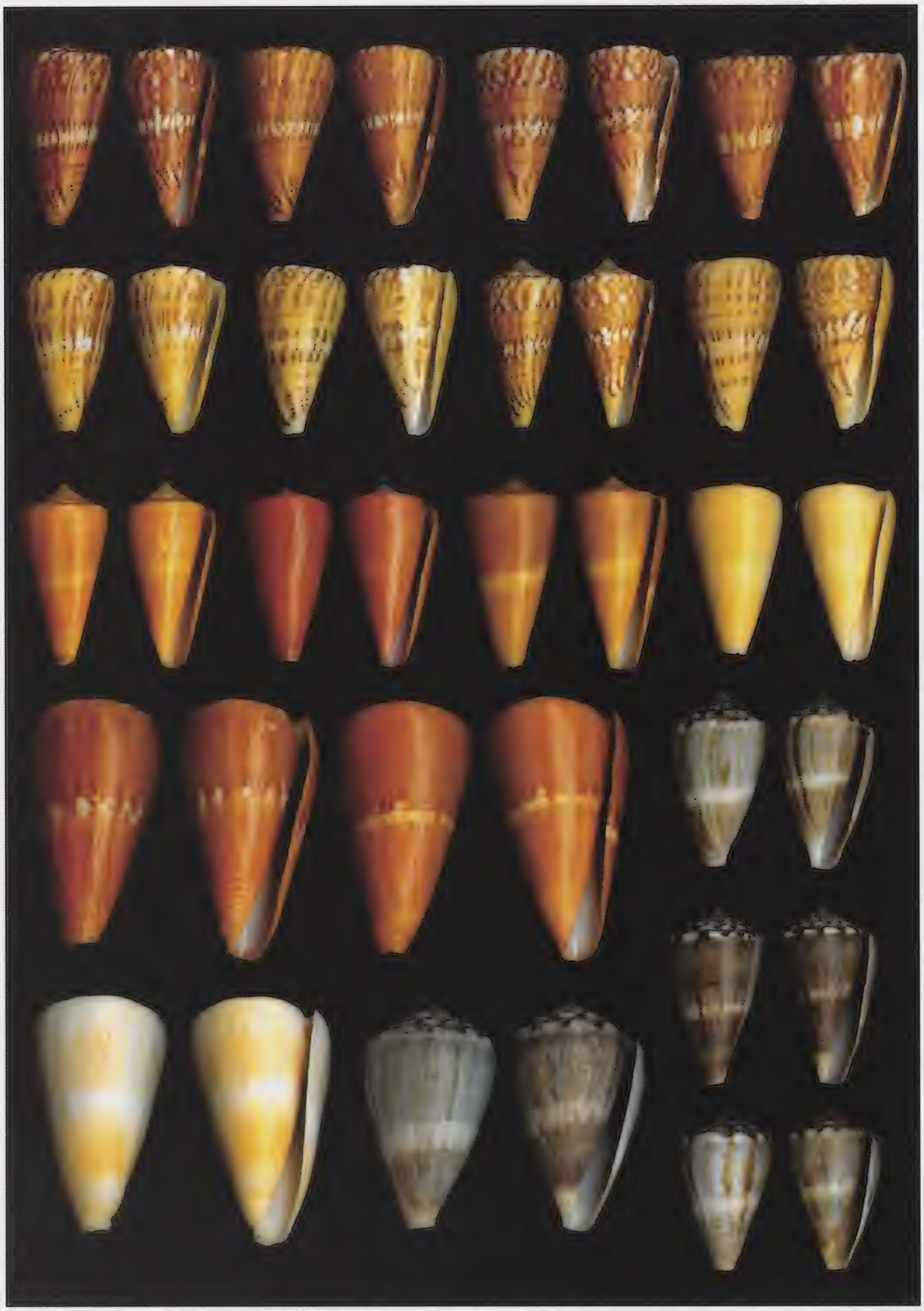


Plate 1. Top row: *Dauciconus boui* (da Motta, 1988) 33.5 mm, 33.3 mm, 30.5 mm, 27.4 mm; Second row: *D. boui* 30.7 mm, 30.1 mm, 31.4 mm, 33.7 mm; Third row: *Dauciconus daucus* (Hwass in Bruguière, 1792) 28.9 mm, 33.0 mm, 32.3 mm, 35.8 mm; Fourth row: *D. daucus* 45.4 mm, 50.2 mm, and *Gladioconus mus* (Hwass in Bruguière, 1792) 40.3 mm; Fifth row: *D. daucus* 46.5 mm, and *M. mus* 44.5 mm, 36.2 mm (upper) and 36.8 mm (lower).

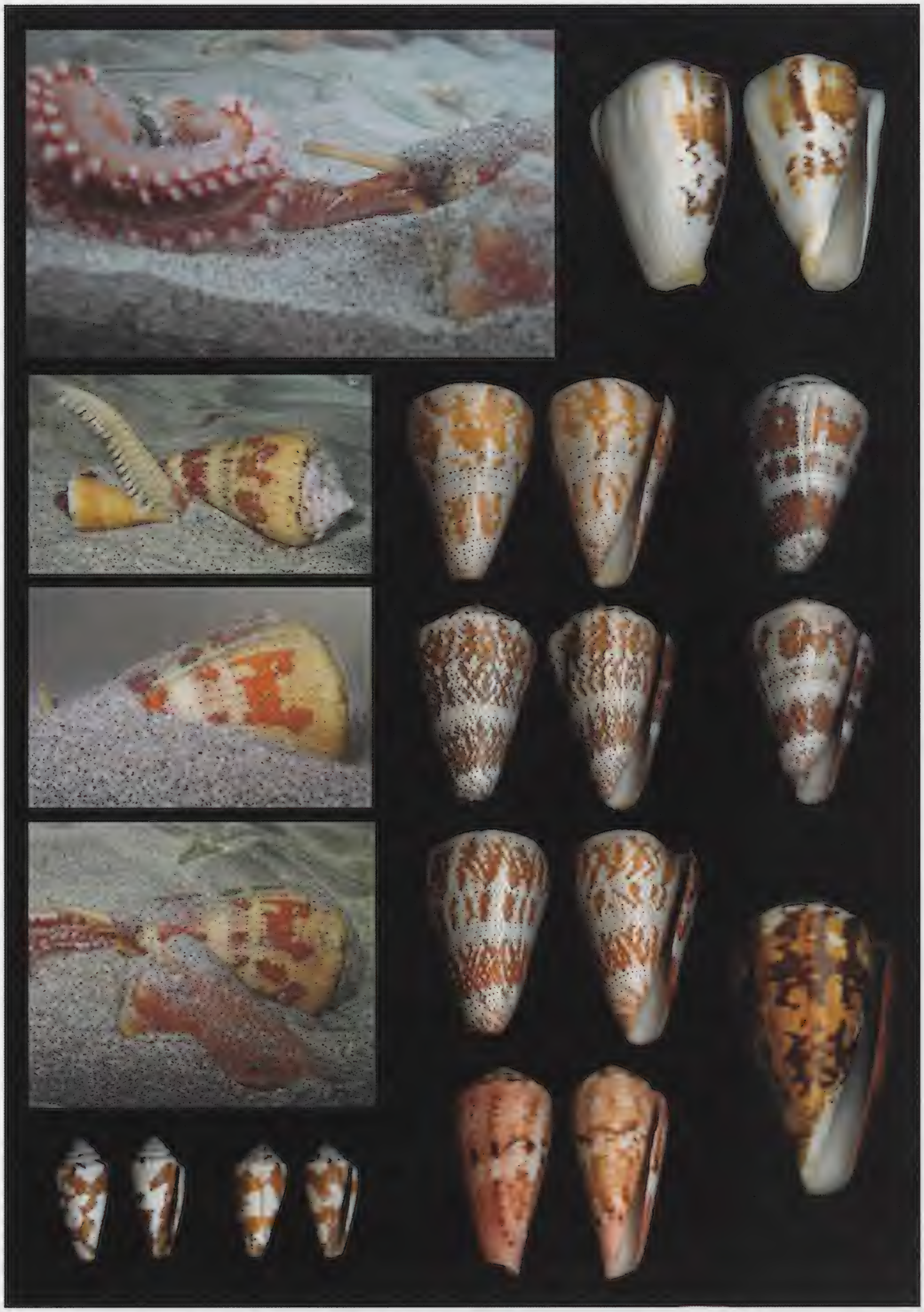


Plate 2. Top row: *Tenorioconus insularis* (Gmelin, 1791) feeding on a fireworm, and *Chelyconus ermineus* (Born, 1778) 65.8 mm; Second row: *T. insularis* and *Stephanoconus regius* (Gmelin, 1791) feeding on a fireworm, *T. dominicanus* (Hwass in Bruguière, 1792) 52.5 mm and *T. insularis* 53.0 mm; Third row: Live *T. insularis* and *T. insularis* 50.2 mm and 50.0 mm; Fourth row: Live *T. insularis* and *S. regius*, *T. dominicanus* 49.1 mm and *C. ermineus* (far right with periostracum) 76.0 mm; Fifth row: *Tenorioconus pseudaurantius* (Vink, D.L.N. & R. von Cosel, 1985) 21.9 mm and 18.0 mm, and *Atlanticonus granulatus* (Linnaeus, 1758) 42.4 mm (beached).

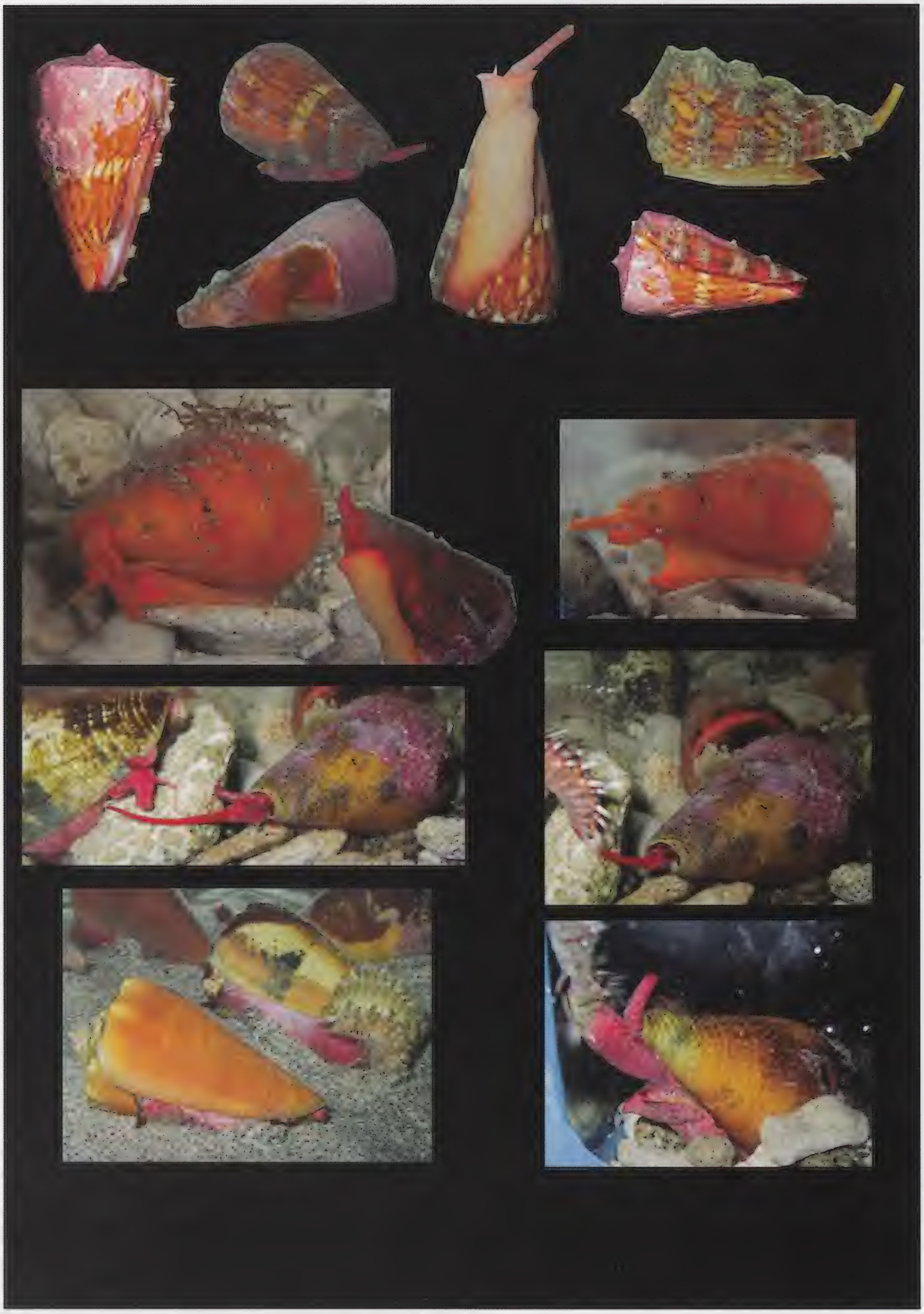


Plate 3. Top row: *Dauciconus boui* (da Motta, 1988) red and yellow; Second row: *Dauciconus daucus* (Hwass in Bruguière, 1792); Third row: *Stephanoconus regius* (Gmelin, 1791); Fourth row: *S. regius*.

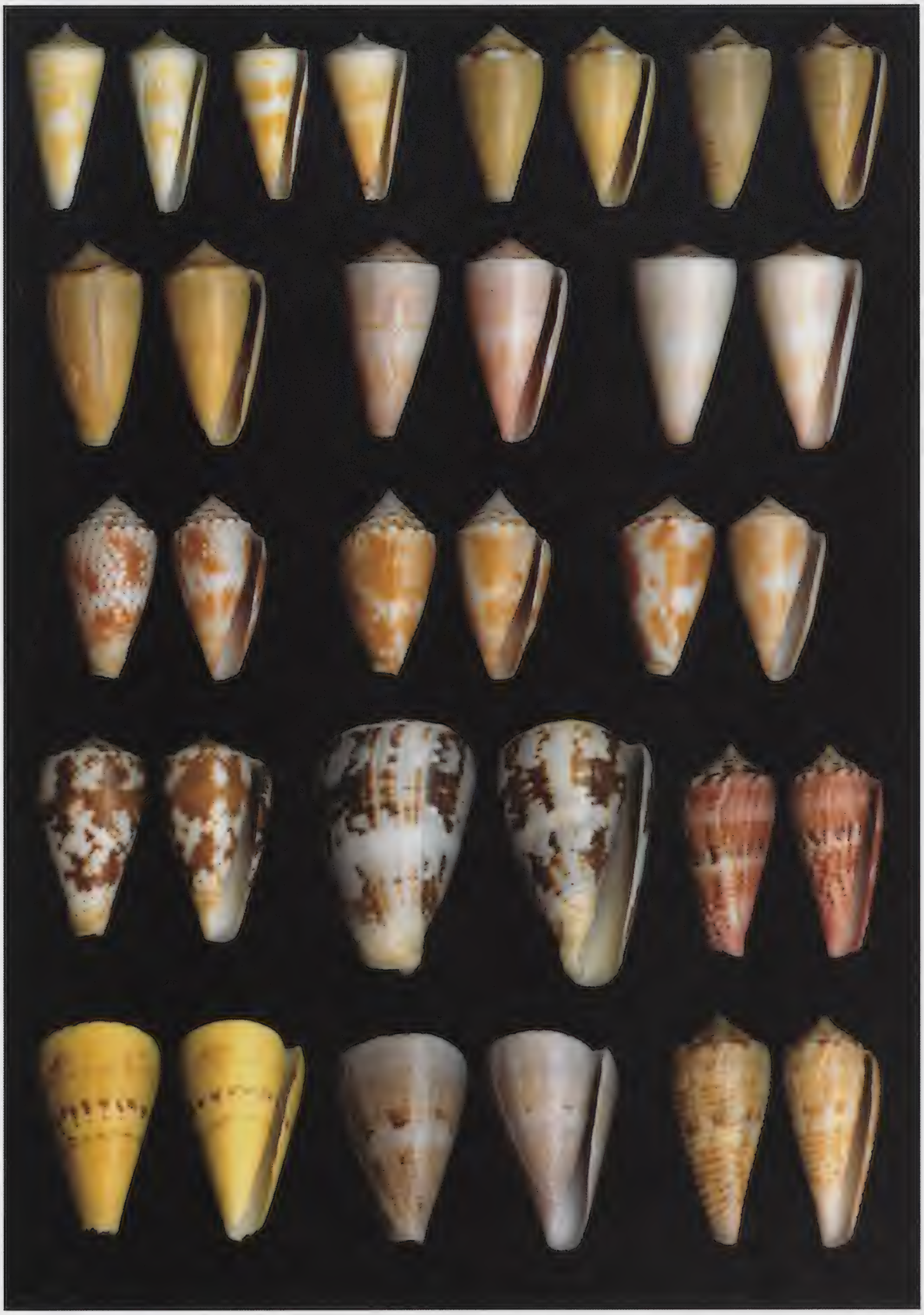


Plate 4. Top row: *Attenuiconus attenuatus* (Reeve, 1843) 18.9 mm and 19.9 mm, and *Poremskiconus colombi* (Monnier & Limpalaër, 2012) 18.6 mm and 19.8 mm; Second row: *P. colombi* 26.4 mm, and *Dauciconus daucus* (Hwass in Bruguière, 1792) 24.0 mm and 30.4 mm; Third row: *Jaspidiconus mindanus* (Hwass in Bruguière, 1792) 25.9 mm, 25.5 mm, and 26.4 mm; Fourth row: *Chelyconus ermineus* (Born, 1778) 40.0 mm and 61.2 mm, and *Atlanticonus granulatus* (Linnaeus, 1758) 30.0 mm; Fifth row: *Dauciconus norai* (da Motta & G. Raybaudi Massilia, 1992) 38.3 mm and 36.6 mm, and *A. granulatus* 28.2 mm.

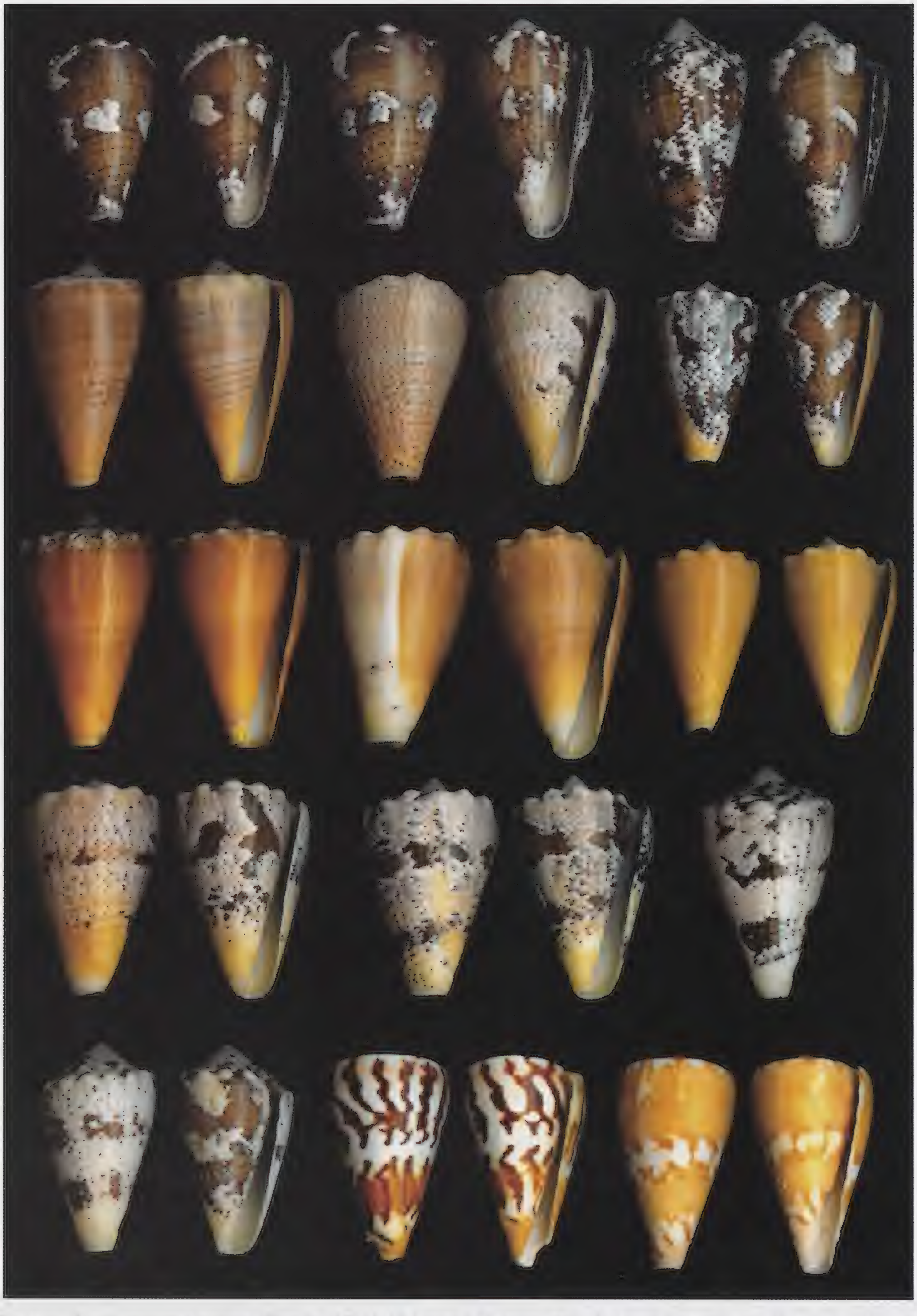


Plate 5. Top row: *Stephanoconus regius* (Gmelin, 1791) 41.0 mm, 37.5 mm, and 41.4 mm; Second row: *S. regius* 40.0 mm, 46.2 mm, and 44.3 mm; Third row: *S. regius* 57.2 mm, 52.4 mm, and 41.7 mm; Fourth row: *S. regius* 59.3 mm, 48.1 mm, and 47.7 mm; Fifth row: *S. regius*36.6 mm, and *Dauciconus jacquescolombi* (Monnier & Limpalaër, 2016) 33.9 mm and 36.9 mm.

ISSN 0738-9388

Volume: 51 THE FESTIVUS ISSUE 2

Quick, massive (~1,000 items), manual digital photography of small (~ 1/10cm) specimens collection by a professional digital video camera and a photo camera zoom lens

Cesare Brizio
World Biodiversity Association, Museo Civico di Storia Naturale di Verona
Lungadige Porta Vittoria, 9 - 37129 Verona, Italy – briziocesare@gmail.com

ABSTRACT A practical, manual workflow to obtain a quick, exhaustive digital photographic coverage of all the items in a collection is described, together with the technical details of the equipment used. Even though no radical technological improvement over similar techniques is adopted, the unique combination of a professional video camera, dimmable indirect lighting, a self-built background stage with a peculiar sliding ruler allowed a particularly quick, easily repeated process to obtain pictures of the required quality.

KEYWORDS Digital Photography, Video Camera, Collection, Seashells

In the community of seashells collector, it's relatively common to observe collections with an adequate digital documented in terms of accompanying data, but completely or partially lacking a digital image coverage, thus hampering information interchange within the conchological community and limiting the scientific importance of the information unaccompanied by visual media.

Here, a quick and relatively economical solution is provided by putting into play a combination of technology and manual procedures that will be proved able to fulfill all the stringent time-dominated requirements detailed further down.

The workflow described in this paper was field-tested to obtain – as quickly and economically as possible – digital pictures of around 1,000 seashells, whose size ranges approximately from 1 cm to 10 cm, covering two sides (in informal jargon, apertural and dorsal) of each specimen, and including a 1mm precision measurement of shell length in at least one of the two pictures of each shell.

Workflow speed

The first and foremost requirement, for obvious economical and practical reasons, is that the image capture process must be capable to provide as quickly as possible a full coverage at the required quality. Any acceptable compromise between quality and processing speed must be carefully evaluated, and may make the difference between a feasible and unfeasible solution. The author was able to engage in the activity only after having designed a workflow that could be completed in a predefined time box: hence this short paper, meant as a proposal to collectors facing the same problem.

Desktop-friendly equipment

A search for simplicity is implied in the above requirement for speed: operationally, the whole process should be managed on a physical desktop where specimen handling takes place (as described further down) in the immediate vicinity of a personal computer. A desktop photographic stand with a table approximating an A4 / Letter size, and with an extensible column of 27÷37 cm range (originally bought with a 15÷25 cm column, then extended by threaded bar and junction nuts) was used in this case. Camera attachment allowed for a further 8 cm vertical adjustment in each direction, bringing the operational range from about 20 to about 45 cm (height of camera tripod receptacle) above the table.

"One Shot per Specimen" approach
To speed up process, just one shot per specimen (in the case of *Oliva* shells: one shot per side, total 2 per specimen) will be taken. This requires that all the conditions (framing, lighting, exposure, focus) could be accurately previewed and fully controlled before each shot.

Required picture resolution
The aim of the photographic documentation is twofold:

- providing adequate coverage of all the diagnostic features of each shells, to allow – wherever possible – an unambiguous determination of the pertinent species: this implies also a good reproduction of colors, and makes fundamental an automatic white balancing feature;
- allow collectors, while holding a specimen in their hands or visualizing a digital image of their own specimen, to perform comparisons with the documented specimens.

Furthermore, the pictures obtained are to be published on a dedicated website.

Those requirements rule out high resolution pictures, whose size is unsuitable for quick downloads and whose exceedingly high level of detail would not be appreciated.

By previous experience of the author, pictures of linear size around 1,000px along the longitudinal axis are sufficient to fulfill the requirements. Thus, any picture resolution providing a vertical size around 1000 px may be generally regarded as suitable. Yet, conditions at the moment of image capture, including the requirement to include a length measurement, may prevent the subject to cover the whole vertical span of the picture. It's therefore reasonable to adopt a vertical resolution at least double than the minimum requirement, in other words 2,000px or more. An 8Megapixel resolution (capable to deliver snapshots of 3,264 x 2,472 pixel) is well suited for the purpose, and will eliminate the need of time-consuming zoom level adjustments for each specimen, that may be successfully covered as long as its maximum vertical length engages at least half of the framed area.

Exceptions apart, considering that the usual length/width ratio of gastropod seashells is very different from monitor and picture horizontal/vertical size ratio, and considering that a zoom lens will be used (see below), it can be expected that the pictures will need individual cropping, to preserve only the informative part of each image and to limit picture size.

In the light of workflow streamlining, and considering that image-capture software may not include a cropping tool, it's wiser to consider postproduction/cropping as a separate successive phase, to be performed massively after the completion of the image capture phase.

A very desirable requirement: tethering with a Personal Computer
As stated above, the digital images obtained will be uploaded on a website, and will normally need a basic postproduction (picture cropping): it's reasonable to desire to manage the whole process smoothly by using a Personal Computer. A device capable to send previews to the PC monitor is therefore preferred, and this may be obtained by USB cable connection / tethering between the imaging device and the computer.

Image format
The jpeg high quality format, even if lossy, ensures the best image quality/image size ratio, provided that high quality/low compression settings are used. If the image capture software, as is the case of DeltaPix InSight,

allows to predefine image saving resolution, the full resolution 8MP 3,264 x 2,472 (or the native maximum resolution of the available equipment) should be used.

Imaging device

Digital photo cameras have several drawbacks, including the following:

- resolution exceeding the requirements outlined above;
- tethering with the PC not always possible – when possible, it's a feature of high resolution models, and thus is incompatible with the desirable picture size;
- if tethering is impossible, the preview is performed only on the photo camera, in a necessarily lower screen size;
- if tethering is impossible, manual transfer of images between the camera and the PC is needed, adding further steps to the workflow;
- as long as the preview is thru the lens as in DSLR cameras or via a small display, the quality of the preview may not allow sound decision in a "one shot per specimen" scenario.

Professional video cameras, instead, are expressly conceived to deliver an on-screen preview and provide one-click capture and real-time image adjustment features, including flexible, real time white balancing. In that respect, video camera pictures may be more color true.

By previous experience of the author, an high quality, USB, professional microscope camera, DeltaPix Invenio 8DII, natively delivering the required 8 Megapixel resolution, was chosen as the best candidate, with its accompanying software DeltaPix InSight. Any comparable USB camera operating in the 8MP range may prove equally valid, provided that it delivers flexible exposition time and appropriate white balancing.

Lens

The objective lens should respond to several mandatory requirements:

- provide a wide zooming range (in line of principle a one to ten range, to cover 1cm and 10cm subjects with the same picture size);
- be parfocal throughout the whole zooming range (in other words, not needing focus adjustments when the focal length is changed)
- provide a very short minimum focusing distance, compatible with a small table stands (in the order of 20cm).

Considering that professional cameras have a C-thread mount, and that C-mount objectives of the required performance are unavailable or exceedingly costly, the only viable alternative are photo camera objectives that, in turn, require a C-thread to camera mount adapter.

Adapters that allow iris diaphragm adjustments are preferable: they allow to set a narrower aperture (that in first approximation translates into an higher depth of field) than the fully opened diaphragm setting, the only available without adjustment.

For previous experience of the author in macro photography, the best price/value ratio is granted by a Sony brand objective, the SAL 1855 3.5-5.6/18-55 SAM lens. Any comparable objective may be used as long as the requirement of a 20 cm minimum focusing distance and very wide zoom range are respected.

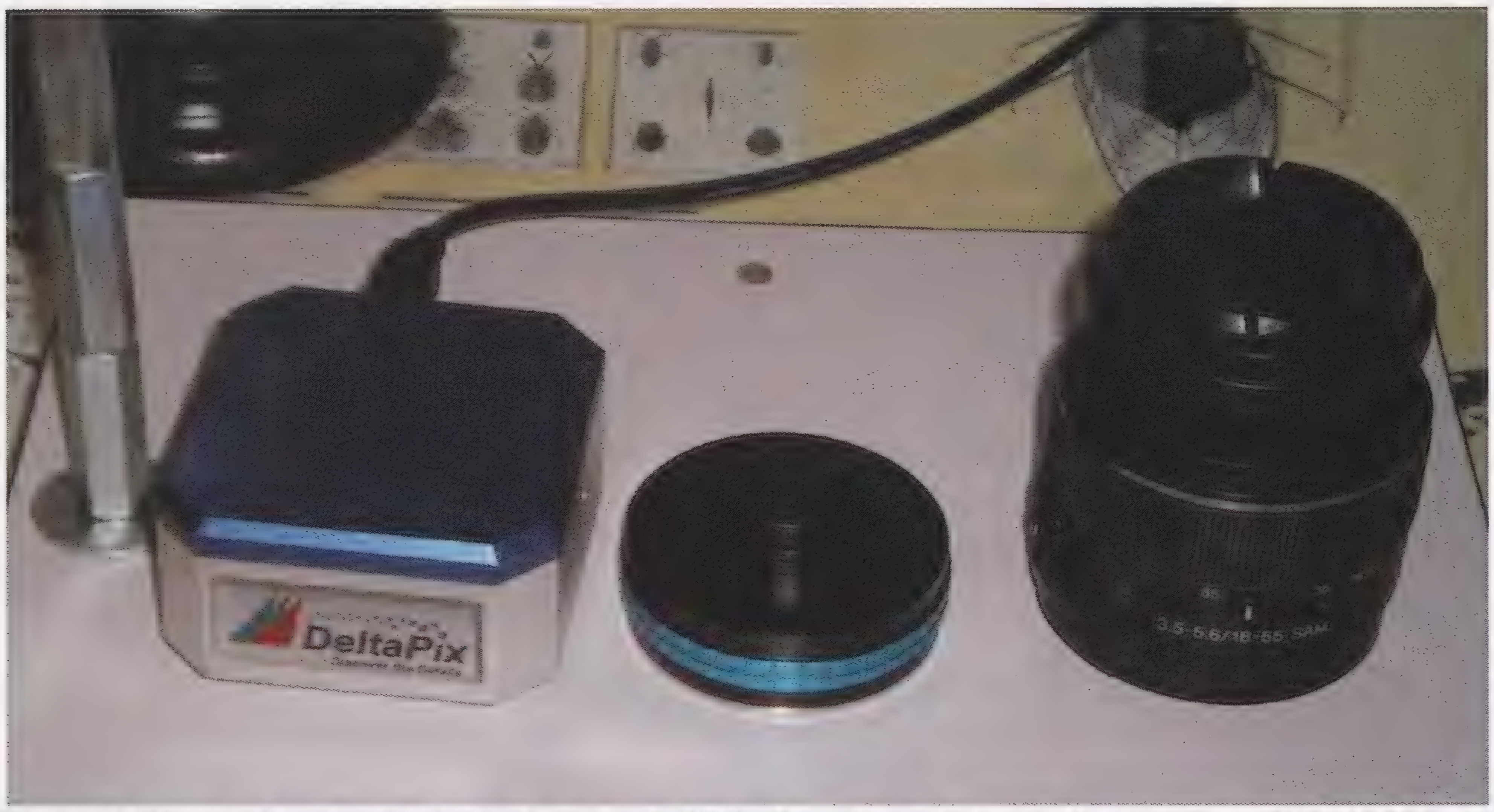


Figure 1. From left to right: DeltaPix Invenio 8DII Camera, C-thread adapter, Sony SAL-1855 lens

Lighting

The availability of an indirect light source greatly enhances the quality of pictures. In the case herein described, a self-built dimmable led-strip illuminator, described online here: http://www.cesarebrizio.it/Photomicrography/LED_strip_illuminator.html, was available and was used even if out of scope: even though it was conceived to enclose fully the specimen, that in theory must lay on the same plane where the illuminator is laying, it was used from above, at some distance (a few centimeters) from the specimen surface. As a consequence of this suboptimal setting, parasite reflections are not suppressed but anyway are greatly limited. Whichever the lighting equipment, care should be taken to avoid too evident reflections that may obliterate significant details of the specimen.

The most desirable lighting source should not only be indirect (capable to generate diffused light), but it should also be continuously dimmable: although the automatic exposure provided by the camera control software is sufficient to ensure a reliable real-time adjustment, it may be unwise to rely only on software to determine the ideal exposure. In the case herein described, a fixed exposure was adopted, and modified whenever the zoom level changed – as long as a wider or narrower field of view changes radically the amount of light available. Once each zoom level was set for a different group of similarly sized specimens, all the pictures were taken with the same fixed exposure setting, usually in the range of 100÷200 msec. In the case of an *Oliva* shells collection, the dimmer was adjusted twice per subject: while the dorsal side is usually less reflective and requires a stronger lighting, the apertural side has invariably brighter and more reflective surfaces, and is overexposed if photographed in the same conditions as the dorsal side. For this reason, the dimmer was lowered until the parietal plications and the details of the fasciole / anterior band could be clearly made out.

It's clear that the dimmer knob must be kept handy during all the image capture session.

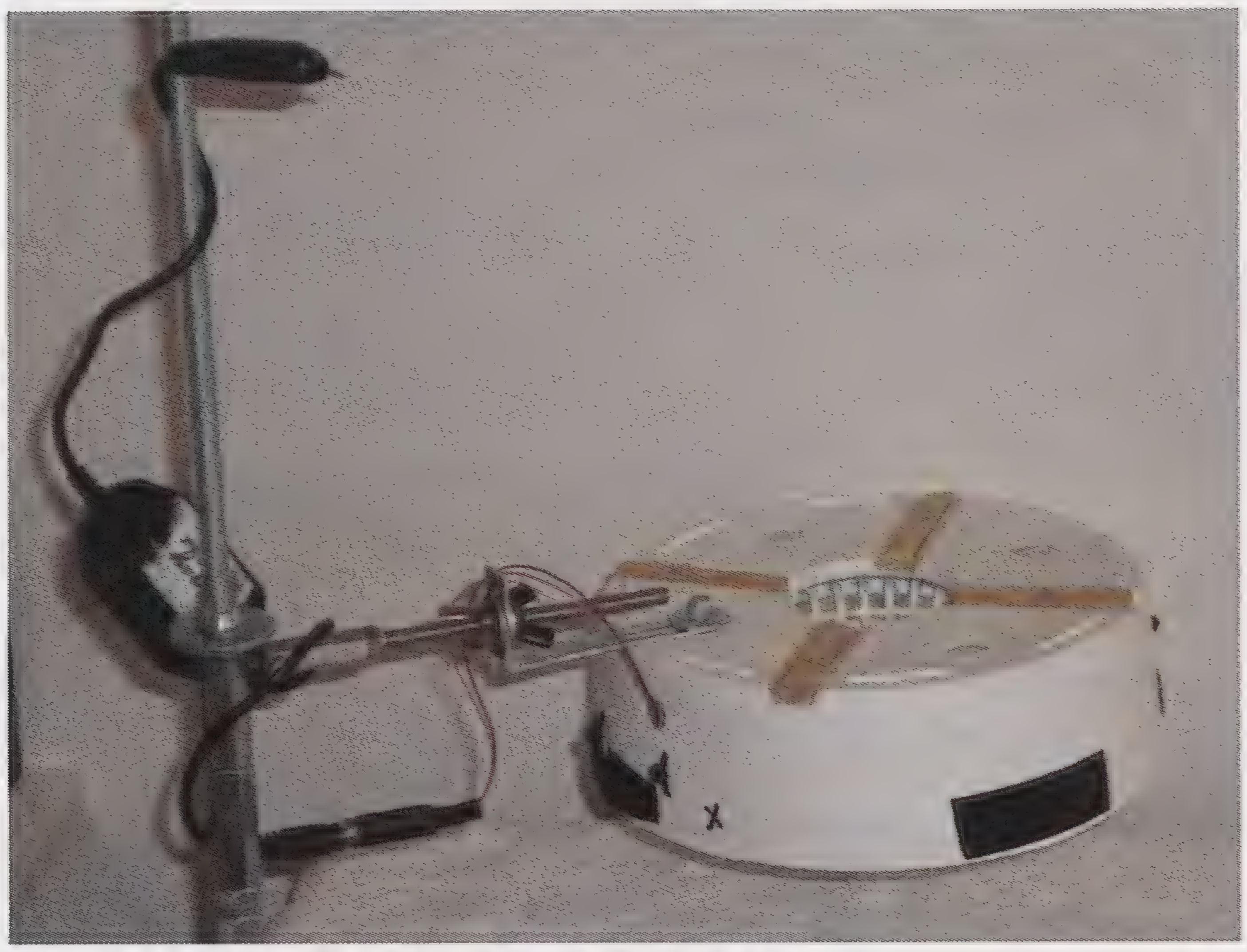


Figure 2. Self-built, diffused light illuminator

Background / measurement stage

The specimen must lay on a special surface providing an even background and some plasticity in particular in the case of rounded objects as seashells that should be firmly positioned at the moment of taking the picture. In the case described here, a small square bag ("cushion") of thick cotton fabric, filled with coarse sand, and enclosed in a wooden frame, was used. This assembly will be referred to as the "background stage". The quantity of sand filling is determined as the amount of sand needed to have the cushion flush with the external frame.

Its size, 11.5 cm, was determined on the basis of the size of the biggest specimen in the collection (around 10 cm). Its color was chosen based on the mostly light-colored specimens in the collection, knowing that to enhance the contours of the darker specimens the superposition of a white fabric square to the cushion would have been required. Even though theoretically a neutral gray cushion would have provided a suitable background for any specimen regardless its darkness, by trial and error this solution was discarded because, depending on the exposure levels and the dimmer regulation, it generated overall less satisfactory pictures. Obviously, any collection may require a different background, and it's wise to adapt the cushion to specific needs.

As stated above, one of the secondary aims of the imaging process, was to provide a reading of each shell antero-posterior length in at least one of its pictures. To that purpose, a precision millimeter ruler, printed on cardboard , was glued to one side of the background stage, with the scale contacting the cushion.

Even before taking a picture, it was clear that, as long as the longitudinal anterior-posterior axis of the shell lies in a plane well above the cushion/ruler, and nearer to the camera, the apparent size of the shell exceeds its real size, as illustrated in figure 3.

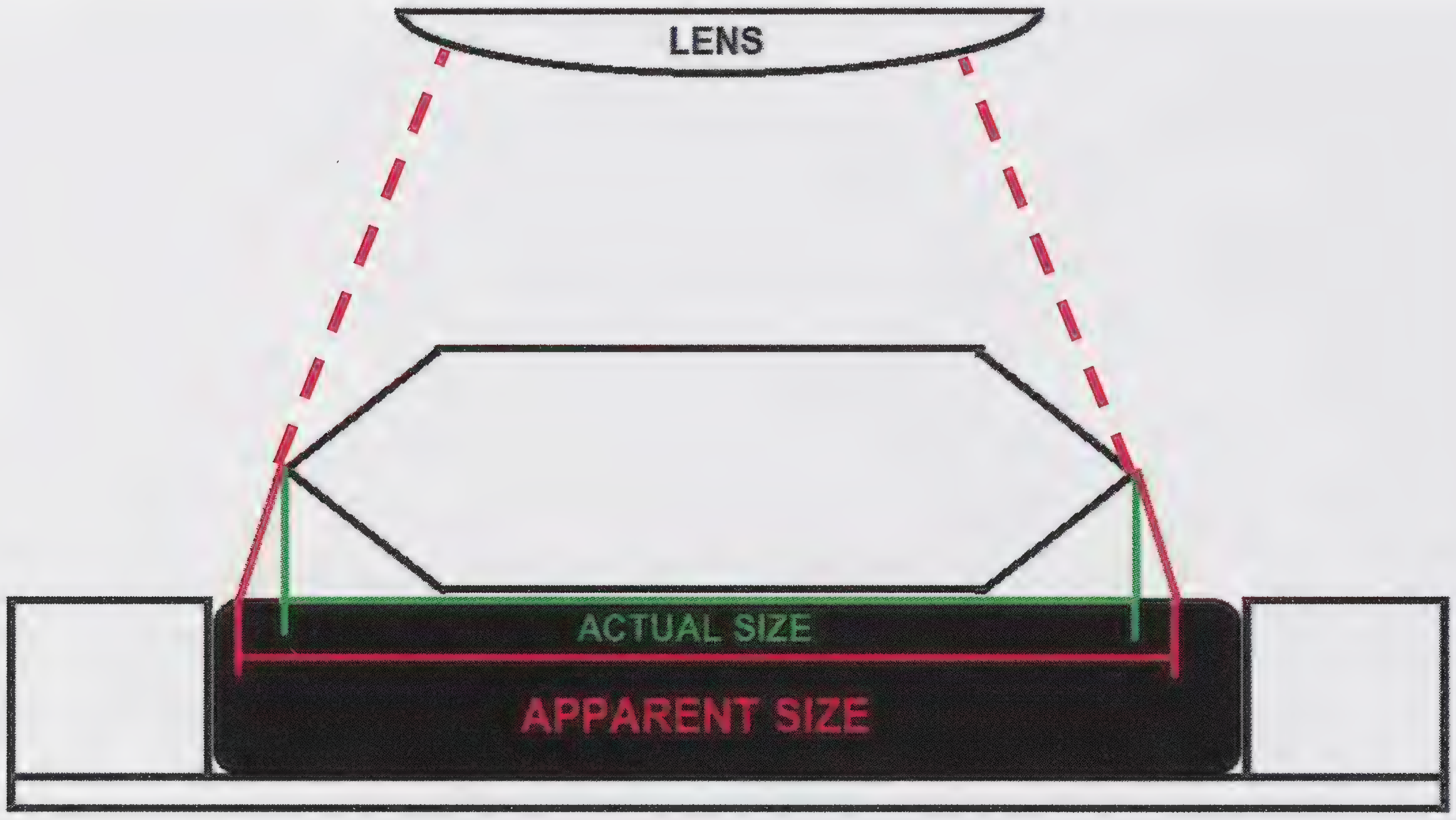


Figure 3. Apparent size of the shell may exceed its actual size if projected on a distant ruler

The only way to provide a reliable, even if approximate, visual measurement, is to prepare a sliding appliance whose surface contacts the millimeter ruler, while an orthogonal surface contacts the apexes of the shell, allowing a reliable reading of the actual distance between apexes at the exact level of the millimeter ruler. This was done by cutting two whole edges form a suitably sized, clear plastic box, as illustrated in Figure 2, and by gluing each of the pieces thus obtained to two short L-profile aluminum sections kept flush with the external frame of the background stage and thus capable to slide above and along the millimeter ruler.

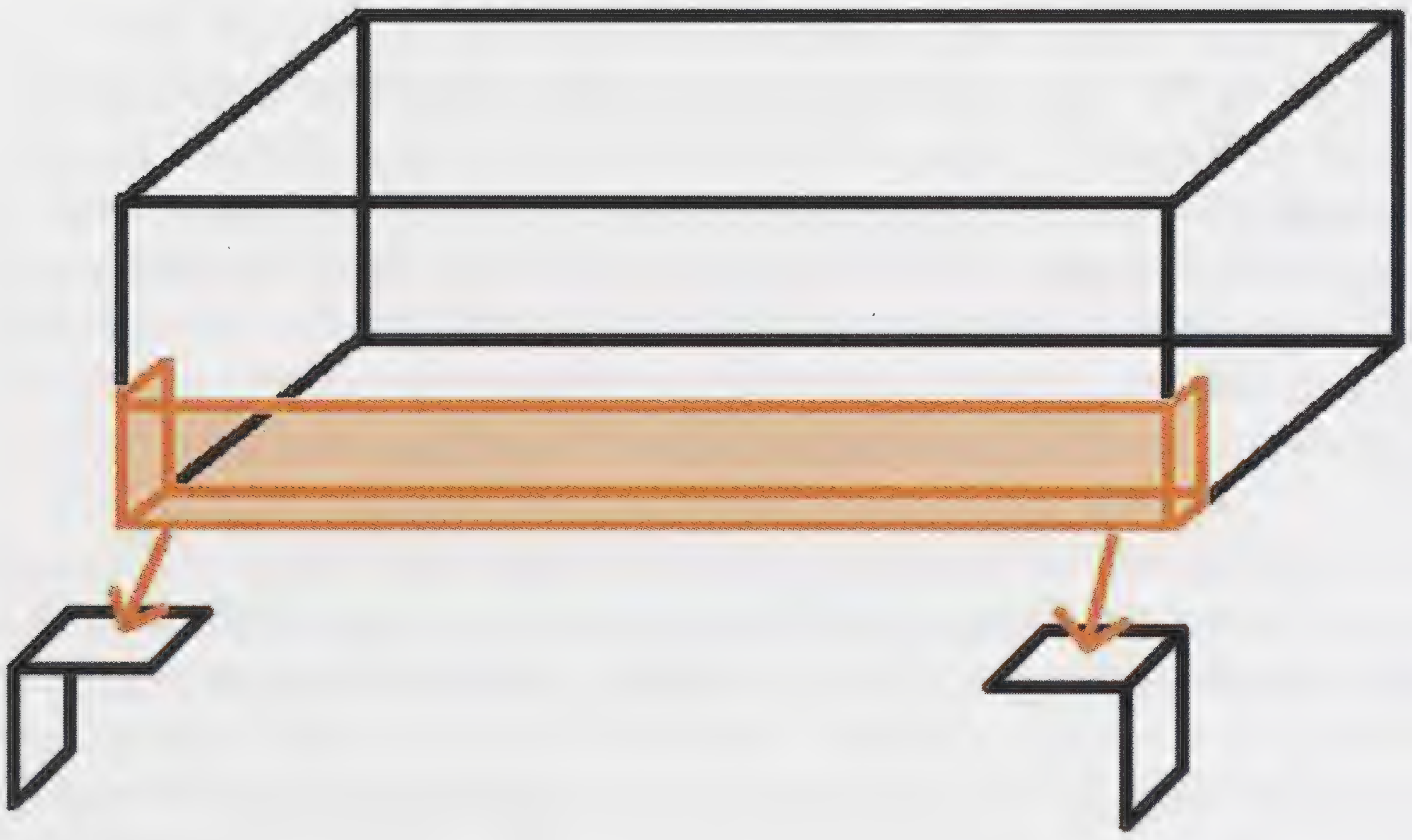


Figure 4. Construction of the sliders: selection of whole edges, including corners, of a clear plastic box

One of the sliders ("lower" or "fixed" slider) was fixed at the 0mm position. To avoid interference with the lighting equipment, part of the plastic was removed, leaving vertical surfaces only in the possible contact areas of the actual seashells, with some generous allowance.

A second millimeter ruler was added on the right side of the frame, to allow a perfect alignment of the top slider, parallel / orthogonal to the frame sides. The final aspect of the stage can be observed in figure 3.

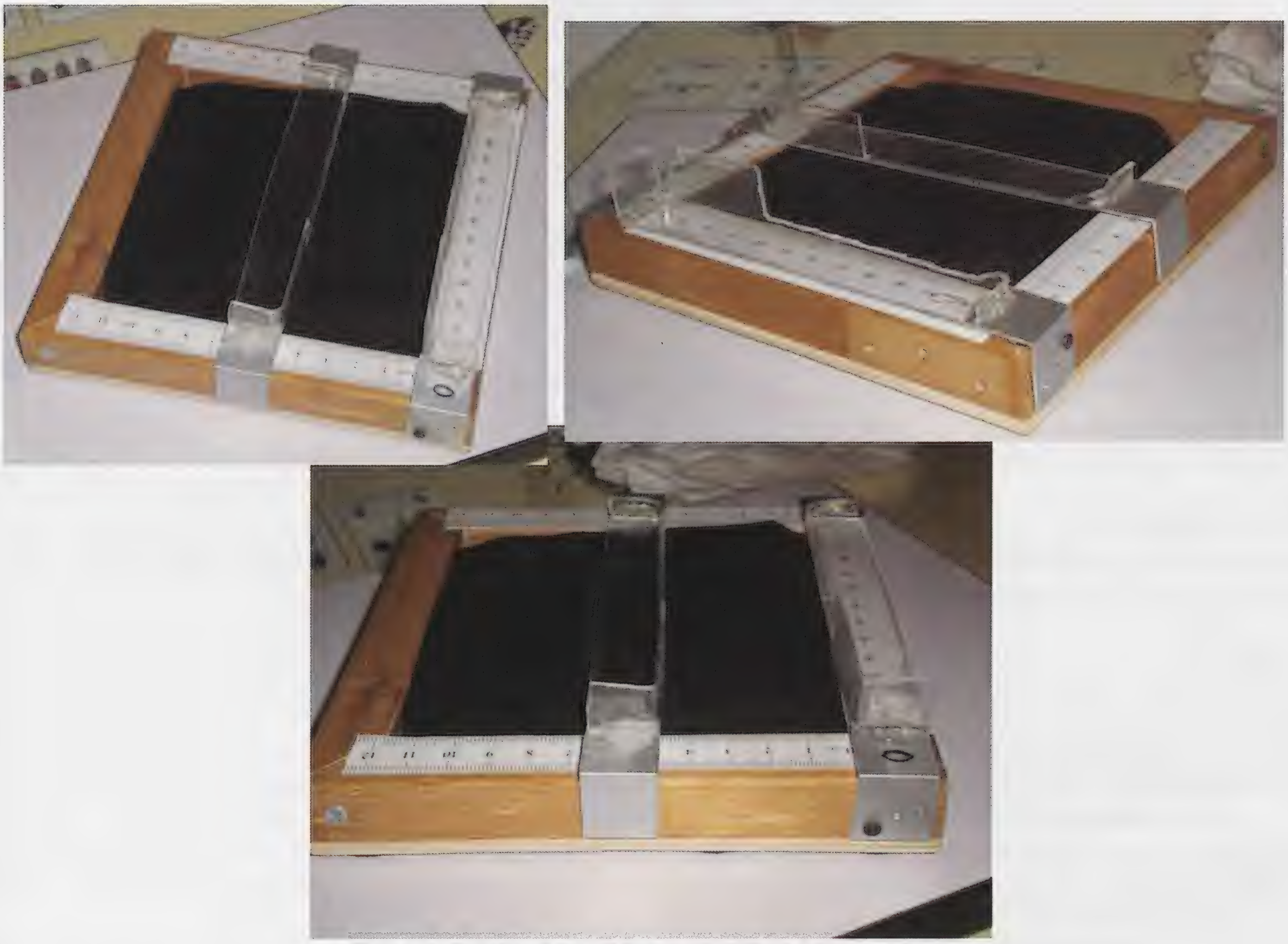


Figure 4. Details of the sliders and of the background stage

Minimum requirements for the collection

In the case here described, all the specimens of the collection are individually numbered and labeled. Plus – although this is definitely not a requirement – they are arranged in special drawers (the most frequent alternative are small clear re-closable bags).

To ensure a correct coupling among pictures and specimens, it's mandatory that each specimen is uniquely identified, the easiest way being the assignment of a number or of another unique code to each specimen. This must be made beforehand, and is usually done by putting a cardboard label alongside each specimen (same bag or same drawer compartment).

Image naming: individual labeling of each item during image capture

By trial and error on a small sample of specimens, it has been determined that the quickest and most effective name assignment to each picture, is obtained by giving to the pictures a name identical to the unique code of the specimen (in this case, two pictures of each specimen are taken, and the picture of the apertural side has a final capital "B" added, as in the following example: dorsal side, 100.jpg; apertural side, 100B.jpg).

The image capture software assigns conventional names, usually based on a progressive number, to the snapshots taken. It's very time consuming, error prone and unpractical to try and change the name of each picture on the fly, during the image capture phase.

As long as we won't assign the final names to pictures during the image capture session, it becomes mandatory to include in the picture an "hook" that allows its successive renaming.

That "hook" is a small (Arial Narrow 8pt bold, around 10x5mm) label carrying only the unique number or code of the specimen.

Although apparently time consuming, the physical pre-labeling of the specimens in fact saves huge amounts of time. The time lost in small label printing, distribution in the collection and – at the moment of taking the picture – positioning of the label aside the specimen is recovered at the moment of renaming the pictures, a process that can be done quickly by visualizing the folder with the pictures in "very large icons" mode and reading directly from the preview icon which name is to be assigned to each picture.

Furthermore, a picture including specimen number is much more useful than a mere file name.

The final installation
Here the technical components of the installation are listed: the software cited operates under Windows 7 Home Premium 64 bit operating system:

Software

- Capture
    - DeltaPix InSight 6.0.5.0
- Postproduction/Cropping
    - Adobe Photoshop Elements 4.0

Hardware

- Personal Computer
    - Gigabyte Brix i3-5010
    - Table camera stand, as described above
- Monitor
    - Dell P2416D (operating at a resolution of 2560x1440 pixel)
- Professional microscope camera
    - DeltaPix Invenio 8DII
    - USB cable
- C-mount adapter
    - Photodiox ProSN (a) – C adapter
- Lens
    - Sony SAL-1855 3.5-5.6/18-55 SAM, Sony A / Minolta Autofocus mount

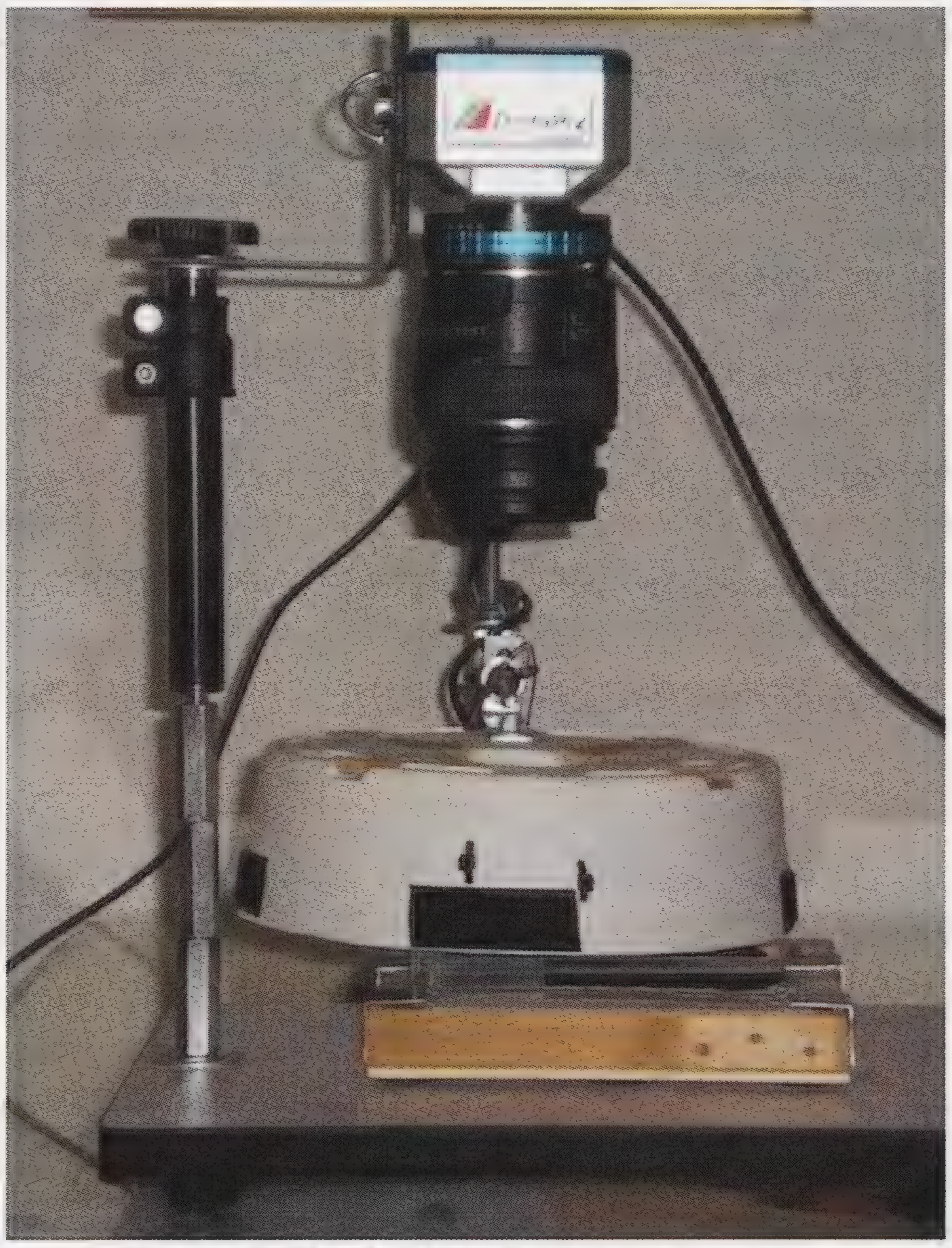


Figure 5. The full imaging setup

The workflow

This is not a detailed step by step guide, considering that the same sequence of activities can be performed under different software and operating systems. Subjects as creation and naming of a folder for the captured pictures, of subfolders for the post-produced or renamed pictures, as well as software setup, will not be covered here and should be part of the basic IT knowledge of anybody engaging in a digital imaging project. Rather, this is a detailed description of the exact steps taken in the case study on which this paper is based.

Preliminary steps

Label each specimen with 10x5 mm label carrying its unique code. Labels may be created as a table with growing number sequence in Excel or Word, or similar software: the table should be formatted until each cell is 1 cm wide and 5mm high, then printed on 200gr/m2 cardboard and separated by paper cutter or scissors.

Each box or drawer cell or bag should be marked with its label **before** the process begins.

Batch size

The process may be carried forward in two ways:

- perform the complete process for lots/batches of specimens
- perform a complete phase for all the specimens, before passing to the subsequent phase. This obviously may imply working on different lots/batches on a daily basis

The second option was chosen and, in successive days, totaling between 4 and 5 hours per day, the images were captured. In the days that followed, in two 6 hours sessions, cropping and postproduction took place.

Batch composition

To speed up work, adjustments should be reduced to a minimum: then, it's better to treat specimens of similar size as a single lot. Specimen size affects zoom level, that in turn may require raising or lowering the extensible column and/or repositioning the camera vertically on its attachment: even though at any given zoom level the lens is parfocal (in other words, maintains the pre-set focus distance), when the lens-specimen distance changes, focus adjustment is needed. For those reasons, treating similarly sized specimens in each session is advisable.

The same may apply to specimen color: considering that – depending on the color of the cushion - very dark or very light specimens may require a different background (*e.g.* a square of white fabric above a black cushion, or vice versa), it would be better to treat similarly colored specimens in sequence.

Suggestions

- Particularly when working on specimens arranged in drawers, some sort of physical signal or "marking peg" must be used to mark the position of the last specimen treated or the next specimen to treat, thus avoiding the omission of whole rows or columns by oversight. When using small bags, it's advisable to put the worked specimens' bags in a separate container to avoid undesired reprocessing.
- For specimen that, as in this case, need to have both sides pictured, it's useless to take length measurements on both sides of the specimen. It was decided beforehand that the dorsal view would be used for measurement, and the apertural view would not include the vertical ruler.
- The ID label should appear in both the pictures of each specimen, thus allowing both the correct naming and the reliable coupling of the two images.
- Considering that the ruler will appear to the left of the dorsal side in just one of the two images, it wouldn't be wise to put the label at the base of the ruler during image capture. By juxtaposing the label to the right of the specimen it suffices to flip the specimen after the first capture, leaving it in the same position respective to the label. On the other side, we should strive to reduce image size: before cropping the dorsal side picture, to minimize its horizontal size, the portion of the picture with the small label was selected and moved at the base of the ruler. This passage is entirely optional, yet compactness is surely a desirable property off the picture, and the select and drag of the label requires just a few seconds per picture.
- The diffused light illuminator illustrated above and used for this case study has a structural limitation: a peeking hole for the lens that, depending on the zoom level, may cause vignetting or obliteration of part of the field of view. The same applies if one uses an annular illuminator not fixed to the objective. The following considerations may not apply to different sources of indirect, diffused light. While taking pictures of the bigger specimens, engaging a larger field of view and requiring a bigger focusing distance, the top of the illuminator occupies increasing areas of the field of view, and the true picture is restrained to a circular area in the field center (see Figures 6 and 7). It's obvious that the nearer to the lens is the hole, the less obliteration will occur: so, why can't we just put the illuminator higher above the subject? The reason why it was unadvisable to raise the illuminator much above the subject is that in fact it ceases to deliver diffused light, and a rapid increase in parasite reflections is observed. A compromise was found but all the bigger specimens where literally photographed "through the hole", and even after cropping some traces of the hole edge may be observed in the corners of some pictures.
- Handling small labels may require the use of tweezers.

Notes about image capture

Image capture and image saving are two distinct operations. Depending on the software used, the procedure to save the captured images may vary. In a general sense, while it's time consuming to save each image immediately after capture, it's much quicker to suspend image capture operation every 10 to 20 captures, and save all the pictures obtained. This is a very quick operation, usually requiring exiting momentarily the image preview feature used for capturing, viewing all the captured pictures as tiles, and press Ctrl-S or another combination to save each picture. As long as pictures will be renamed in a subsequent phase, the name automatically assigned to each picture can be confidently accepted: the presence of the numbering small label in each photo will guide us at the moment of renaming. Since the acceptance of the default name for each picture requires just to press enter (the OK button is usually pre-selected), saving each picture would require: one click to select the tile with the picture; just two keystrokes: Ctrl/s and Enter; one click on the "X" (close) button of the tile of the image just saved. After saving all the captured images, one returns to the preview/capture screen and continues the activities.

Image capture

The procedure adopted for *Oliva* shells is described here: it may vary depending on the nature of the specimens photographed.

For each batch

- (optional) if the cushion color is unsuitable for the specimen, change cushion or cover the cushion with a square of fabric of suitable color;
- adjust zoom level for the maximum expected size in the batch;
- if at minimal focal length (widest field) the shell is not entirely visible, raise the camera (by increasing column length or moving the camera above on its attachment;
- if the camera was raised, check and adjust the focus

For each element in the current batch:

A. pick the shell and the small label (if applicable: at current peg/physical marker position);
B. put the shell on the background stage, gently pressing it on the cushion, dorsal side up, near the left (vertical ruler) side, upright, with longitudinal axis vertical and its anterior apex laying on the 0mm lower (fixed) slider;
C. put the label at the right side of the shell: the left side of the shell should be as near as reasonable to the vertical ruler, leaving some space on the left to maintain visible the outline of the shell above the cushion (the shell should not touch the frame). By arranging the label at the right side of the shell, it will suffice to flip the shell and slide the whole background stage a little to the left to exclude the ruler from the apertural side picture; the nearer to the shell is the label, the tighter the cropping can be made, resulting in a smaller image file.
D. Slide the upper (movable) slider towards the shell until it touches the protoconch. If sand has moved inside the cushion, bumps may have formed and the slider may not touch both the sides of the frame. Bumps should be flattened by gently moving the slider up and down, until it touches, on both sides, the rulers and, on its front vertical face, the protoconch. Verify that the same reading occurs on both left and right rulers;
E. position the background stage under the camera;
F. adjust luminosity with the dimmer, to the highest setting where no parts of the picture are overexposed (unnaturally white). Usually, when taking the second picture (apertural side), intensity should be decreased as the fasciole and "shoe" of the shells are very reflective;

G. verify that the upper and lower readings of the vertical ruler, including the sliders' bases, are visible, that the small label is readable in full, and that the shell is upright;
H. capture the image. See above "Notes about image capture";
I. put away the shell and the small label;
J. (if applicable: move the peg/physical marker to the next position);
K. see if it's time to save the images captured: in case, save the images as explained in "Notes about image capture";
L. repeat the sequence from point A.

When fluency in this phase is obtained, if the shells are arranged in easily accessible drawer cells with no box or bag to open, the A-L iteration should take no more than 25 seconds.

Renaming

At predefined intervals (typically, at the end of a day's work), or in any case when the image capture phase is completed, pictures, now assigned default meaningless names, should be manually renamed according to their actual content.

To proceed, it suffices to select the folder containing the captured images, maximize it and select the "details" visualization, from which an alphabetical ascending order by filename will be chosen. Then, once the alphabetical order is in place, visualization is changed to the "very large icon" mode. In 8Mpixel images, the 1 cm label should be clearly visible up to a specimen size of 8÷9 cm, only for specimens above 9 cm the label may have become so relatively small as to become unreadable. Only in those cases it may be needed to open the image to read its specimen number. In the actual case here described, the label could be read from "very large icons" in all the 1,832 pictures made. In this case study, the name assigned to each picture, as stated above, is its unique ID, with an added final B for the apertural side picture.

Postproduction

Once the pictures are taken and renamed, they should be cropped to preserve only the meaningful part of the picture (see the two examples in Fig. 6 and 7). To this purpose, Adobe Photoshop Elements (as well as many other graphics software, including open source and freeware solutions) provides an effective tool for image cropping, that can be invoked by a single keystroke.

It's suggested to open groups of 6 to 10 pictures by dragging them on the graphics software window, then for each picture:
A. select picture,
B. select the cropping tool,
C. select by dragging the tool the area to preserve,
D. adjust area size and position
E. press enter to actuate the cropping,
F. press Ctrl-W to save the cropped picture, and then enter as required, always checking that best quality JPG option is selected at the moment of saving
G. repeat sequence from point A

(keyboard shortcuts may vary with the software).

In the case study here discussed, another activity took place: to reduce image size further, before cropping the dorsal side pictures, the portion of the picture with the label was selected and dragged at the base of the ruler, thus allowing to preserve a narrower area. This was made by different combinations of keyboard shortcuts and mouse (or trackball) action, that may vary depending from the graphics software.

The excellent color and white balance response of the combination of Invenio 8DII and DeltaPix InSight did not require the use of "auto levels" function. With different devices, it may be useful to use the automated batch procedures of the graphics software to apply "auto levels" (contrast, brightness, color cast removal) to the cropped images. In that case, it will suffice to specify a source and a destination directory, and the software will generate new pictures with auto levels applied.

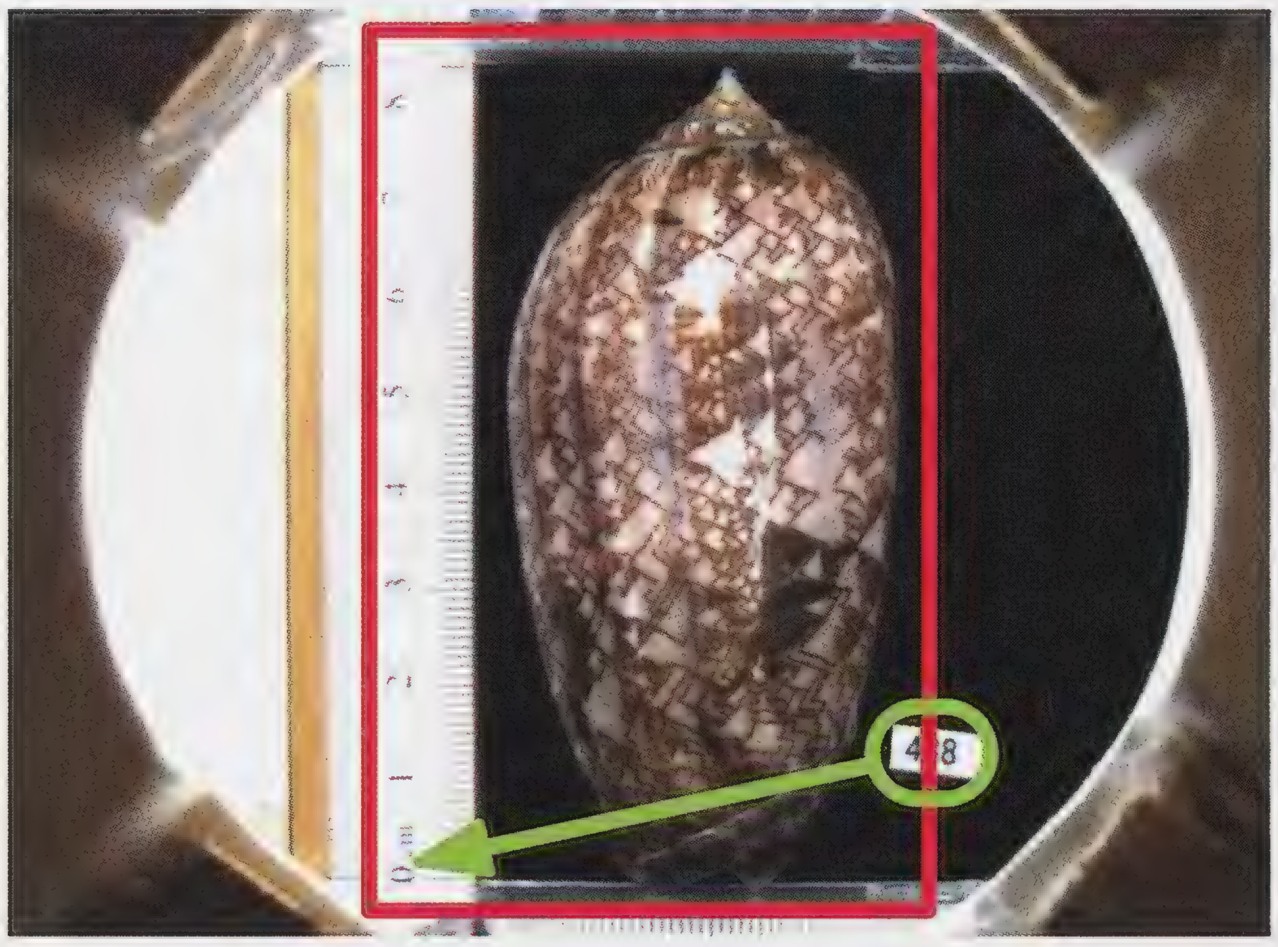


Figure 6. Dorsal side picture, specimen near the ruler. Label Repositioning (green arrow) and Image Cropping (red line)

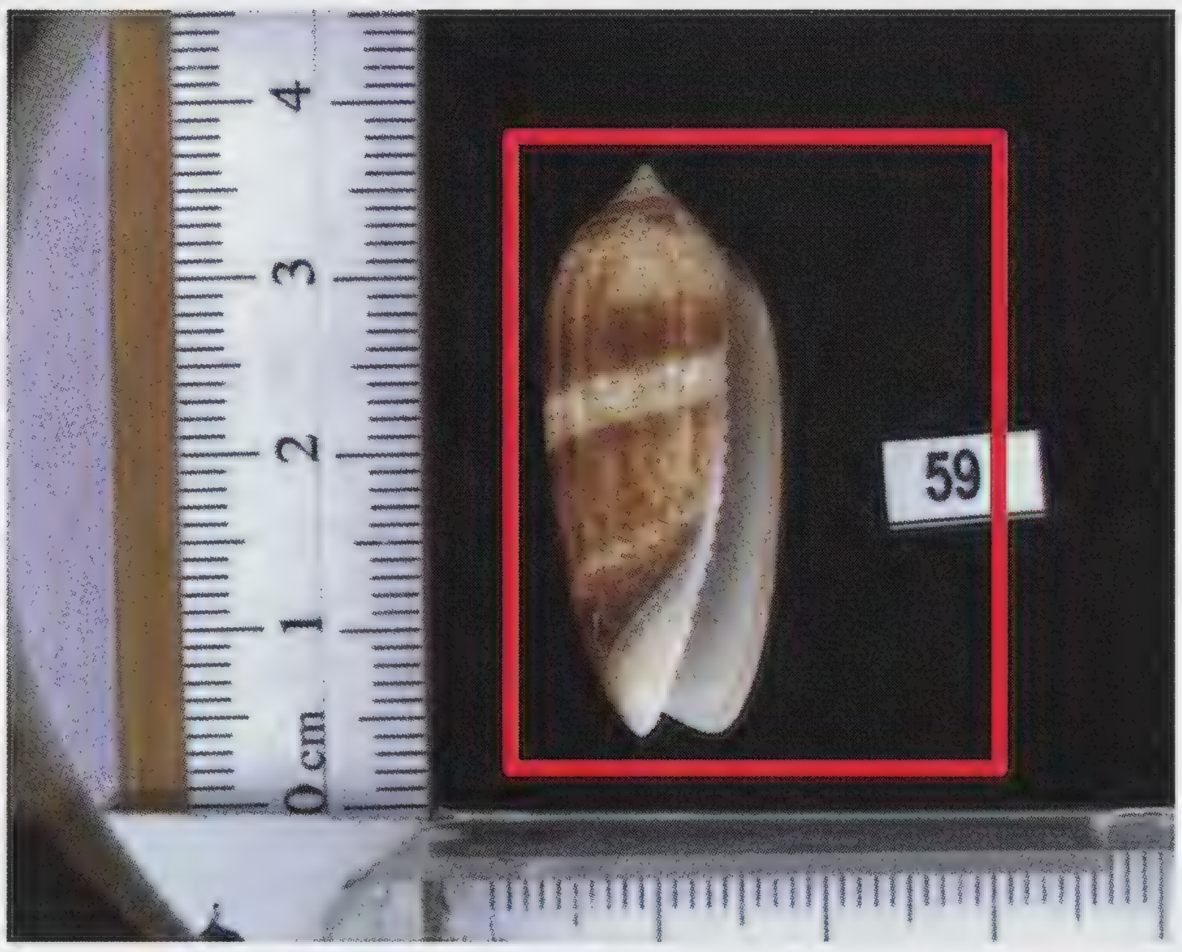


Figure 7. Apertural side picture, specimen away from the ruler. Simple Cropping (red line)

Thumbnail generation

Once the pictures are taken and renamed, if their destination is a website it may be desirable to generate much smaller thumbnails/previews to be put on a web page for giving access to full size pictures.

This operation can be automated by most graphics software. In the website structure, it is wise to keep in separate subfolders the full size pictures and the thumbnails, respectively. The web page will be placed in the main folder and access both. The automated batch resizing procedure allows to specify different origin and destination folders.

Results

The times provided here are influenced by 30+years of author's experience in IT tools and in graphics software, but the ease of the iterative operations described above points at the possibility that any average PC user, after some times of use of his own favorite image capture and graphics software, can match or improve those results.

Production

The combination of technological stack and workflow described above allow the author to take 1,832 pictures (including specimen handling, picture saving and renaming) in under 28h (divided in 6 days, averaging 4h40' per day), equal to around 1,680 minutes averaging 55 seconds all-inclusive time per picture capture, saving and renaming, with custom lighting for each picture.

Post-production

Post-production operation including cropping and label repositioning (an optional activity whose omission would have significantly reduced working time) were performed in two successive days in a total of 12 hours, equal to 720 minutes averaging less than 24 seconds all-inclusive time per picture post-production. Around 30 cases of unreadable labels where solved by adding a digitally generated label or moving labels from a picture to another: those operation did not alter significantly the overall performance.

Conclusions

All the pictures obtained may be accessed here: http://www.cesarebrizio.it/oliva/index_olive.html, by a click on the corresponding thumbnail (warning: the download of the thumbnail page, currently having 1,832 entries, may require one or more minutes).

All the pictures were individually checked and fulfill the requirement to cover adequately the diagnostic features and allow comparisons with other images or physical specimens.

For the scenario of one-shot, medium resolution, massive capture of images of catalogued collections, even though time constraints did not allow to process the same specimens with different imaging devices and workflows, it seems that the combination of technologies and techniques here described has a decisive advantage over other kinds of manual workflow involving the use of photo cameras.

Suboptimality of the pictures

The pictures obtained do not represent the maximum possible quality obtainable with the proposed combination of camera and lens, but rather the best compromise between speed and desired quality. Among the steps not taken that would have ensured an even better image quality:

- zoom was not customized for each specimen, but for each batch;
- focus was not adjusted on each specimen, but on the first specimen of each batch, with occasional readjustments;
- fixed exposure time was not adjusted for each specimen, but for each batch (as long as illumination was individually dimmed for each capture, this should not be a problem);
- diaphragm aperture was identical in all the 1,832 pictures (to avoid introducing a further variable in exposure), while in fact it could have influenced picture sharpness at different zoom levels and focusing distances.

The excellent technical characteristics of the imaging equipment, and the generally good quality of the lighting equipment, allow to obtain a more than reasonable result considering that one and only one shot was taken for each subject and side combination.

A side benefit of image naming: from excel to HTML table in a few simple steps

An HTML web page can be seen and downloaded here: http://www.cesarebrizio.it/oliva/index_olive.html

It contains all the pictures obtained via the process described above, and as of August 2018 is still unrefined. Thanks to image names exactly matching the unique code of each shell, the table filling the body of the HTML page (containing all the thumbnails and the data of each specimen) was automatically generated from the same Excel sheet where the data of the collection are stored. This was made possible by a basic knowledge of HTML and by the usage of simple Excel functions. Details will be provided upon request.

E. adansonianus adansonianus (Crosse & Fischer, 1861),Bahamas, 106.1 mm. *B. poppei* (Anseeuw, 2003), Tonga Islands, 58.8 mm. *P. amabilis* f. *maureri* Harasewych & Askew, 1993, USA, 42 mm. *B. tangaroana* (Bouchet & Métivier, 1982), New Zealand, 55.9 mm. *P. quoyanus* (Fischer & Bernardi, 1856), Curaçao, 50.7 mm. *B. philpoppei* Poppe, Anseeuw & Goto, 2006, Philippines, 65.1 mm. *B. charlestonensis* Askew, 1987, Martinique, 77.3 mm. *B. midas* (Bayer, 1965), Bahamas, 82.7 mm.

YOUR CONCHOLOGICAL HOME ON THE NET

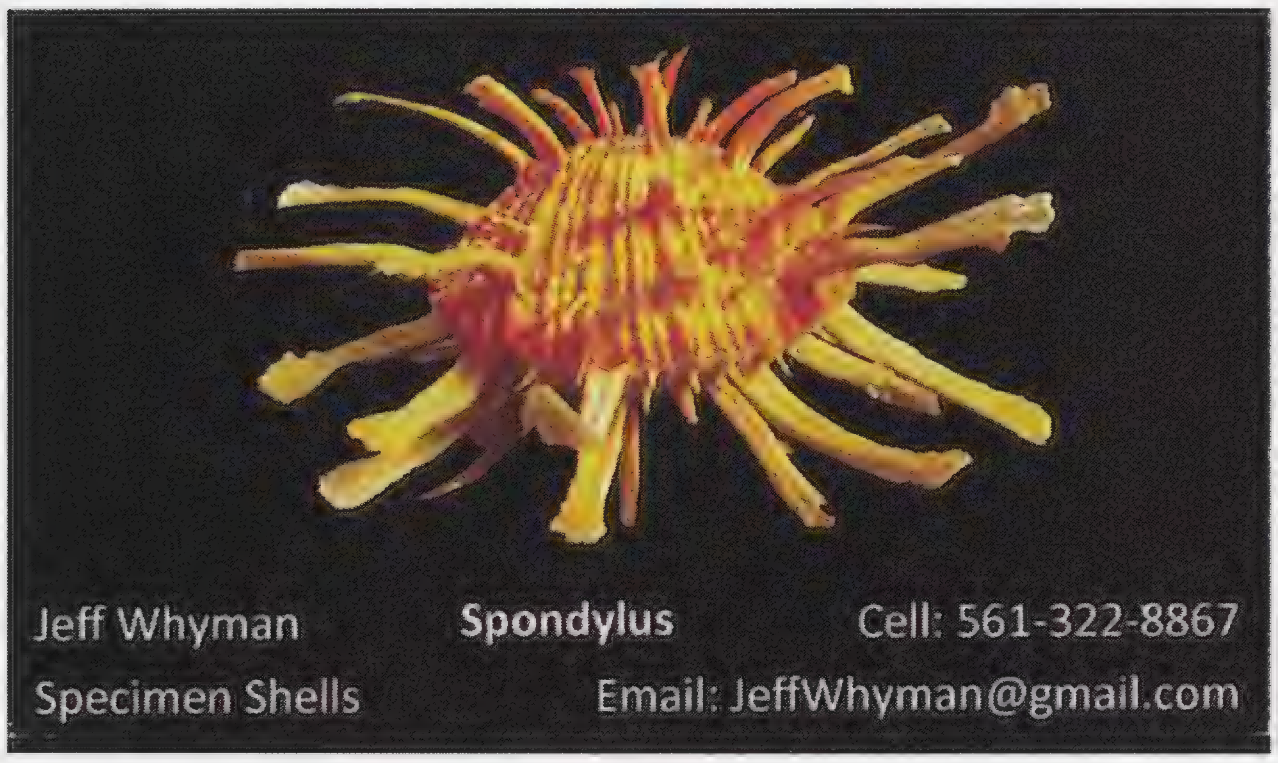
140,000 pictured specimens of common and rare shells for your collection.

Conchology, Inc. continues to develop its conchological goals by supplying worldwide collectors with the best quality and the best documented shells. Conchology, Inc. is powered by Guido and Philippe Poppe together with a dedicated staff of 24.

www.conchology.be philippe@conchology.be

Cebu Light Industrial Park, Basak, Cebu 6015, Philippines
Tel: +63 32 495 99 90 Fax: +63 32 495 99 91 www.conchology.be

Conchology, Inc.



Jeff Whyman
Specimen Shells
Spondylus
Cell: 561-322-8867
Email: JeffWhyman@gmail.com

E: vicmarshells@gmail.com

VIC-MAR
Shells
SPECIMEN TRADING

P: +63.917.768.3223

Vic Dungog

Cont. # : +63.917.5512639
LINE, WECHAT, WHATSAPP

Sitio Lupa, Punta Engano
Lapu-Lapu City, Cebu
Philippines 6015

Lyria kurodai

Fulgoraria ericarum

SINCE 1975

VIETNAMESE SHELLS

American
CONCHOLOGIST

Calendar membership (Jan - Dec) = $25 (USA)
Postal surcharges: + $5 for USA first class,
Canada & Mexico + $5, other nations + $15

New members apply to: Linda Powers
2700 N. Beach Road, Unit D106
Englewood, FL 34223-9223
linda.powers1@gmail.com

Quarterly Journal of the Conchologists of America, Inc.

30
YEARS
ANNIVERSARY

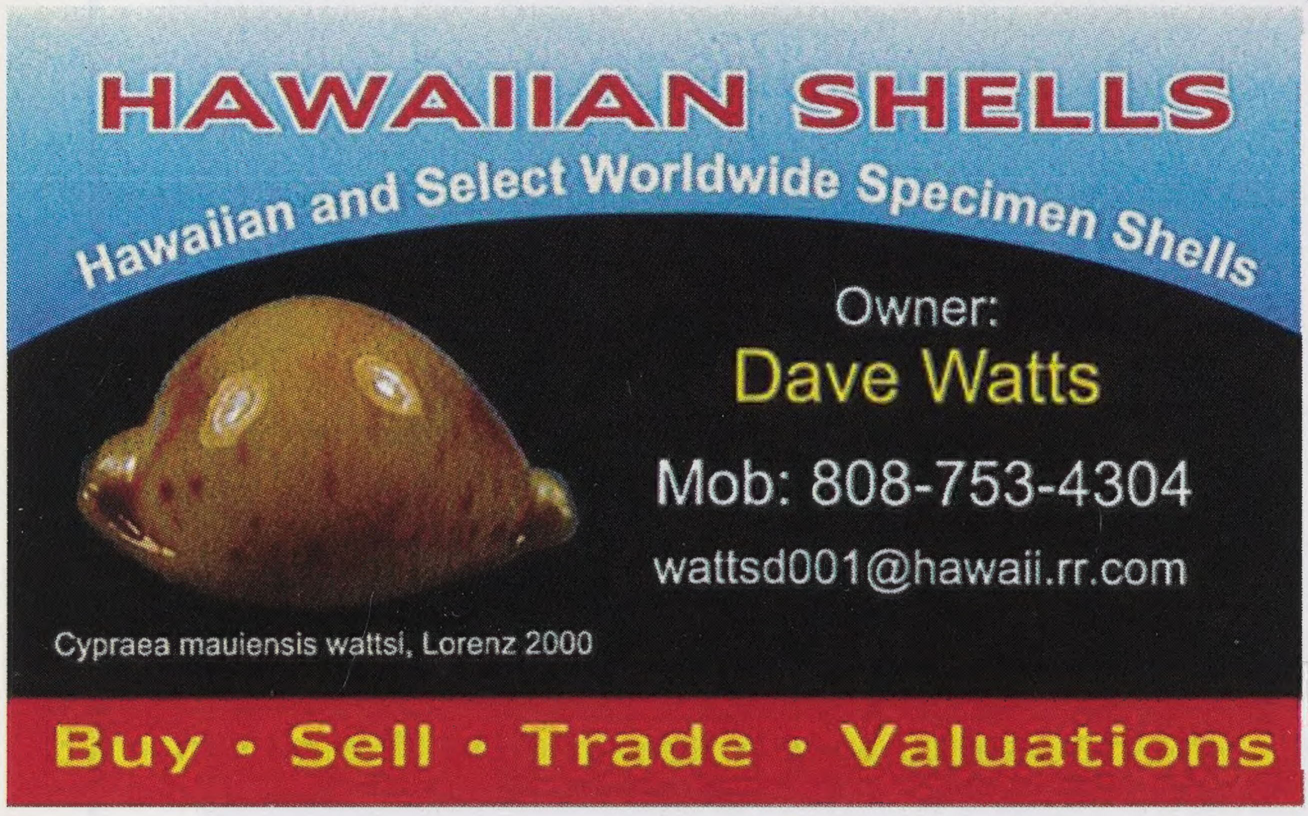
femorale

SUBSCRIBE TO
OUR WEEKLY LISTS
WE BUY OLD COLLECTIONS

Jose & Marcus Coltro
www.femorale.com
shells@femorale.com

WORLDWIDE SPECIMEN SHELLS
Est. 1977
Your One Stop Marine & Land Shell Connection
www.worldwideconchology.com
P.O. Box 6088, Columbia, MD 21045-8088; U.S.A.
Richard L. Goldberg
worldwide@rcn.com
Telephone: (443) 535-0427
Mail Order · Collection Appraisals

TEL: 619 507 8438
Charles Hames
shelldoc@hotmail.com

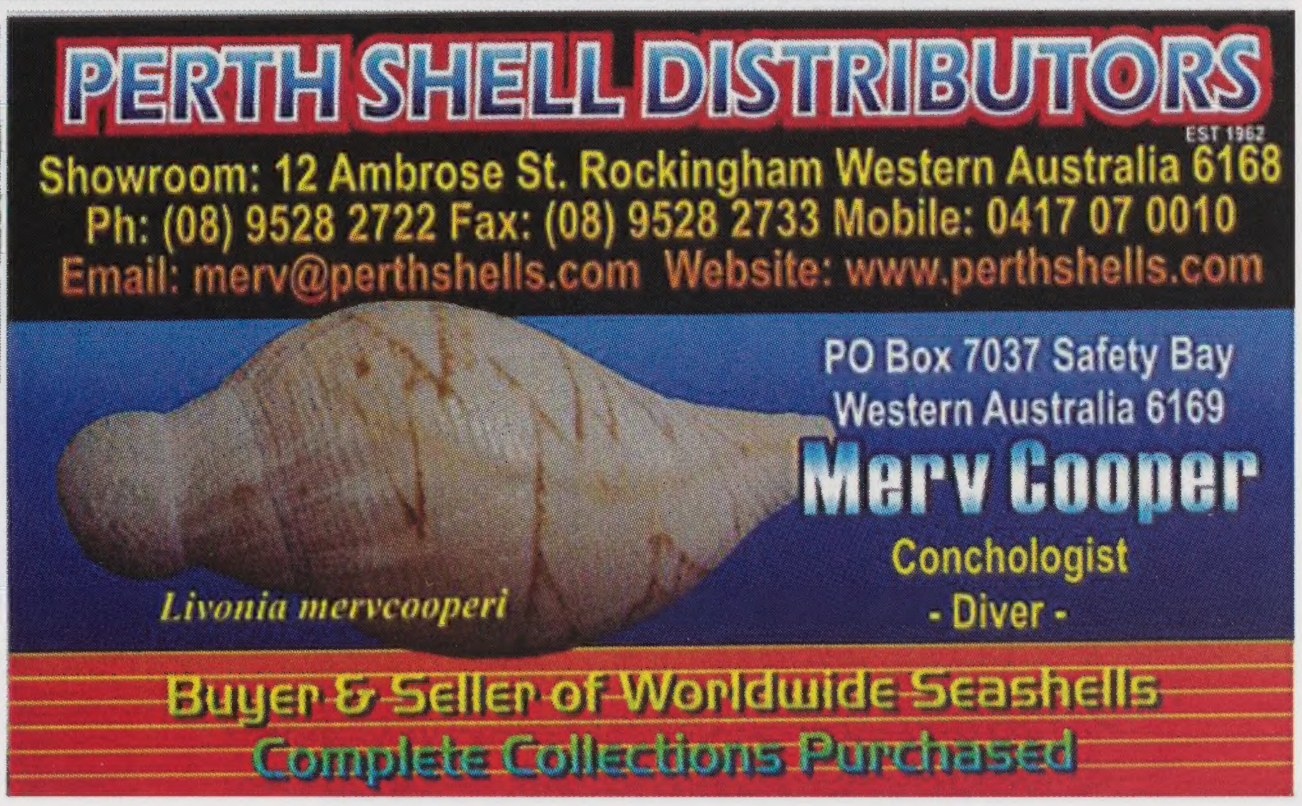

HAWAIIAN SHELLS
Hawaiian and Select Worldwide Specimen Shells
Owner:
Dave Watts
Mob: 808-753-4304
wattsd001@hawaii.rr.com
Cypraea mauiensis wattsi, Lorenz 2000
Buy • Sell • Trade • Valuations

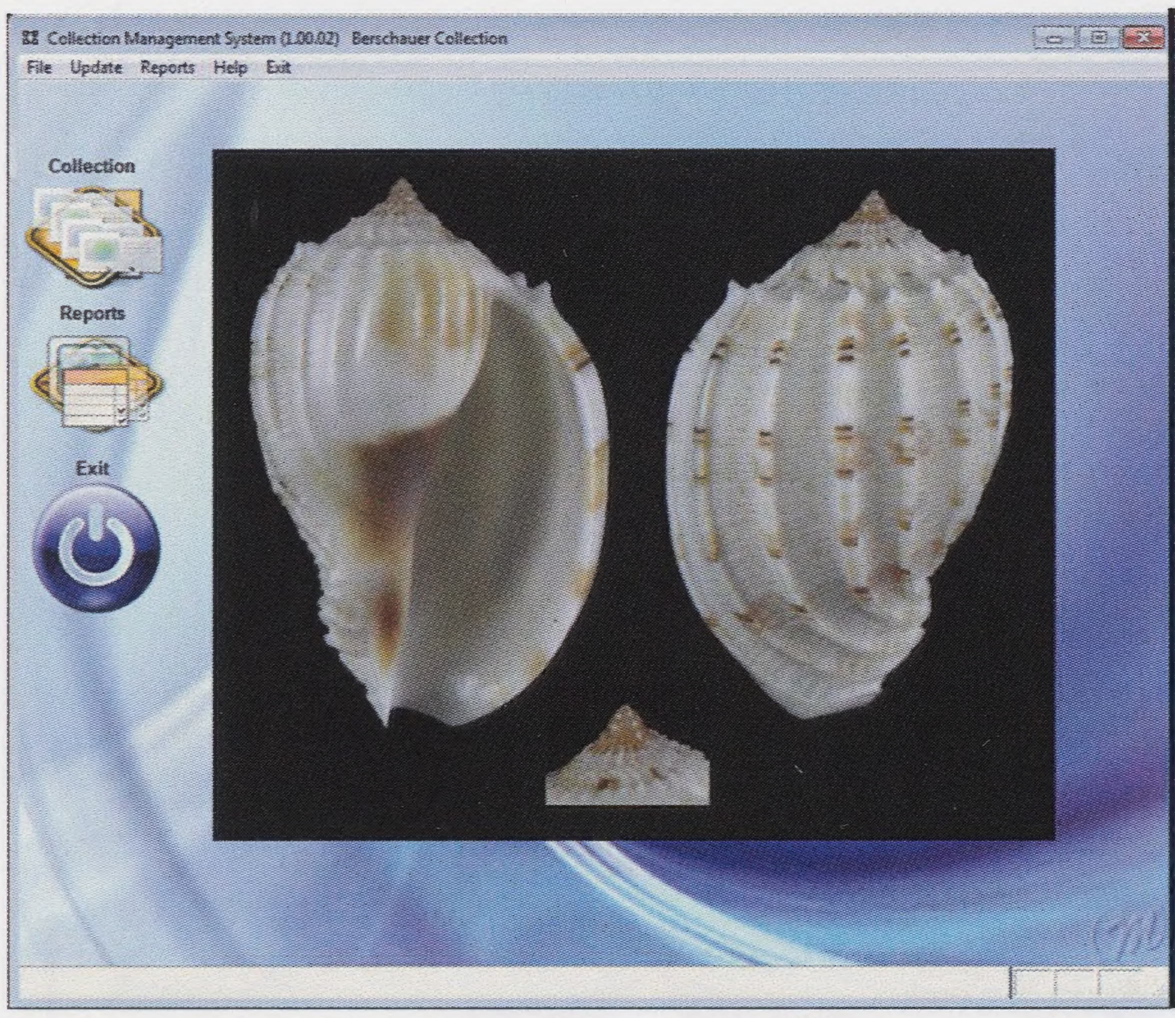
DONALD DAN
QUALITY SPECIMEN SHELLS
AND BOOKS
6704 OVERLOOK DRIVE, FT. MYERS, FL 33919 U.S.A.
TEL. (239) 481-6704 • E-Mail: donaldan@aol.com

http://www.dedondershells.com
FERNAND & RIKA DE DONDER
Melsbroeksestraat 21
1800 Vilvoorde – Peutie
BELGIUM
Tel : +32 (0)2 253 99 54
e-mail : fernand.de.donder@telenet.be
WORLDWIDE SPECIMEN SHELLS
10 Minutes from Brussels Airport. Visitors welcome.
All Families from the very common to the ultra rare,
Worldwide shells : specialized in the smaller families, West Africa and European shells.
Free list on request, good quality shells at the best prices.

Sue Hobbs
Specimen Shells
P.O. Box 153
Cape May, New Jersey
08204-0153
USA
Telephone 609-884-7601
suehobbs@verizon.net

RICK & CHERYL NEGUS
RICK NEGUS SPECIMEN SHELLS
Quality Seashells Reasonable Prices
760 434-9808 home
760 521-8215 cell
rnegus@roadrunner.com
www.californiashells.com
Panamic & Worldwide Specialist
Uncommon / Rare in Stock
Want Lists Filled
E-Bay Dealer TICKKERS


PERTH SHELL DISTRIBUTORS
EST 1962
Showroom: 12 Ambrose St. Rockingham Western Australia 6168
Ph: (08) 9528 2722 Fax: (08) 9528 2733 Mobile: 0417 07 0010
Email: merv@perthshells.com Website: www.perthshells.com
PO Box 7037 Safety Bay
Western Australia 6169
Merv Cooper
Conchologist
- Diver -
Livonia mervcooperi
Buyer & Seller of Worldwide Seashells
Complete Collections Purchased


Collection Management System (1.00.02) Berschauer Collection
File Update Reports Help Exit
Collection
Reports
Exit

Got shells? You need to keep them organized. *Collection Management System* is a museum style database program, which enables a collector to keep, organize, and maintain the individual records and data in a readily accessible form. The program is easy to use and is menu driven. Allows you to work with any systematic collection, print reports ***and labels***. Check out FB or our website www.shellcollections.com for more information. CD or downloadable versions are available.

Club Conchylia e.V.
German Shell Collector's Club
Our journals:
- Conchylia
- Mitteilungen
- Acta Conchyliorum

Yearly subscription rate: 50.- €
Further informations:
www.club-conchylia.de
Dr. Manfred Herrmann
Ulmenstrasse 14
D-37124 Rosdorf
e-mail: club-conchylia@gmx.de

afc

Be a member of **AFC**, the French Conchological Association and receive free our quarterly **Xenophora** magazine and its supplement ***Xenophora Taxonomy***, enjoy our various Shell Shows in France all over the year.

Association Française de Conchyliologie
2 square La Fontaine
75016 Paris - France

Visit our site www.xenophora.org

Subscription Europe : 55 euros
Other countries : 65 euros
Pay by Paypal at souscription@xenophora.org

PHILLIP CLOVER
Dealer in Specimen Since 1960 Worldwide Sea Shells Specializing In Ancilla, Cancillaria, Conus, Cypraea, Marginella, Mitra, Latiaxis, Morum, Typhis, Voluta and Out-of-Print Shell Books
PH/FAX# 707-996-6960 Free lists
Email:clovershells@juno.com
P.O. Box 339 - Glen Ellen, CA 95442

Algoa Bay Specimen Shells

Marginella hayesi

P.O. Box 97564
Northridge, Raleigh, NC 27624
http://www.algoabayshells.com/
(919) 931-6197 Brian Hayes
Contact: algoabayusa@gmail.com

SHELL COLLECTIONS WANTED
And also other Marine Life collections.
We will find good homes for your shells ... many of which will be placed in a Shell Museum of education for children and others.
Call for a price evaluation.
Brian Hayes at: (919) 931-6197

Back cover: *Scaphella junonia junonia* (Lamarck, 1804), *Scaphella junonia butleri* Clench, 1953, *Scaphella junonia curryi* Petuch and Berschauer, 2019, *Scaphella junonia elizabethae* Petuch and Sargent, 2011, and *Scaphella junonia johnstoneae* Clench, 1953. (Cover artistic credit: Rex Stilwill).

SMITHSONIAN LIBRARIES
3 9088 02018 2879